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Dry Reservoirs in France

DRY reservoirs are assumed in the popular mind to be a novelty in engineering, and even engineers generally are not aware that they date back at least 200 years. The short article by Kenneth C. Grant in this issue shows that two basins of this type were built in France in 1711. They do not conform to the conventional idea of a reservoir, which requires that the valley be closed by an unbroken dam. The impounding structures on the Loire and Upper Loire are really channel contractions which restrict the flow to the capacity of the channel below and hold back the peaks of the floods. In principle, however, they do not differ from the dry reservoirs proposed on the Great Miami and described in this journal last week.

Comparisons of Flood-Control Systems

IN this issue is the first of a series of papers by H. A. Petterson comparing different systems of flood control. The final conclusion reached at the end of the series is that engineers should give more consideration than they have in the past to reservoirs—a conclusion that is corroborated by the decisions in favor of reservoirs at Dayton and Pittsburgh, even in the face of initial belief by the engineers in the adequacy of channel improvements. While all of Mr. Petterson's conclusions, as the papers appear, will not be accepted without modification by many students of the subject, they should bring about a more impartial attitude toward impounding basins. They bring together much scattered information and represent a prodigious amount of work in compilation and analysis.

Illumination of Road Surfaces

AS an instance of the difficulties which an inexperienced person can inject into a subject which already is sorely trying the ability of specialists is the suggestion, recently made by an eminent illuminating engineer, that one of the elements in a successful road surface is its behavior at night under poor illumination. In other words, he proposes that engineers in selecting a surface give consideration not only to its ability to withstand traffic, but also to the ease with which objects may be distinguished against it at night. Dark asphalt surfaces, he remarked, reflect not more than 10 per cent of the light falling on them; in some cases the reflection is less than this, and rarely as high as 15 per cent. A horse and buggy, for example, become visible at night against a dark highway only when one is fairly upon them, while on a dirt road or light pavement they loom up large at a considerable distance. The difference in visibility is naturally of much importance to fast automobile traffic. While it is unlikely that engineers will take this matter into consideration now, in view of the many elements in pavement success so much more important, it is worth while bearing in mind, particularly when the color can readily be lightened, as by a dusting of Portland cement over sheet asphalt.

When More Water Must Be Had

WHEN the question of an adequate water supply is raised in a city every summer, on account of deficiency or danger thereof, heroic measures sometimes become necessary. It requires no great stretch of imagination to realize that the quantity of available water is sure to limit the size of our Western American cities. Far-sighted engineers have used the argument before city officials when urging them to provide for future needs, and William Mulholland's laconic remark to the Los Angeles city fathers, to the effect that they would not need the Owens River supply if they did not go after it, undoubtedly won the day. Five years ago Centralia, a comparatively small town in the heart of Illinois, was face to face every summer with a formidable water famine. Constitutional limitations prevented the raising of sufficient funds to get an adequate supply. In this predicament the mayor in 1909 unloaded the water problem on a committee of seven citizens, to whom was given full authority to devise and carry into effect plans to provide an adequate supply. The method of getting a report and learning from technical experts what was possible was not unusual, but the ingenious financial methods by which $135,000 was raised in four days, as detailed on another page of this issue, will give many a small town hope and a cue as to how it also may bring things to pass when the slogan is not "We can," or "We will," but—"We must!"

Engineers for Alaska Railway

CREDITABLE discharge of its contract with the American people in the building of the Alaska railway demands of the Administration primarily the selection of a competent personnel. In the original draft of the measure the purpose was plain to put the work in the hands of the army. That provision, however, was killed in the House. This is fortunate, for, with all possible admiration for the army, it must be admitted that its members are not railway engineers. That is a profession separate from theirs, in which success depends on a lifetime's experience. Panama will be pointed to as an evidence of the army's ability to put through an immense project. But the analogy holds only insofar as efficient management is necessary in both. Technically—in design and construction—the problems are different. In one—canals and waterways—the army has had a century's experience; in the other—railways—it is a tyro. The fact that on the commission there was only one practical railroad man proves nothing, except the incapacity of the representative who drew the act of authorization. There would be advantages in having army engineers, with their high sense of honor and effective methods of organization, represented in the managing commission, but the final responsibility for the routes, grades, curvature, etc., must rest with railroad engineers. This must be fully appreciated by the President and his chief adviser in this matter, the Secretary of the Interior, in organizing the Alaska work.

Marketing of Timber

OBJECTION has been made to the editorial in the Engineering Record of March 21 entitled "Vigorous Work Needed in Establishing Timber Standards." That editorial, among other things, charged the producers of timber with unscrupulous methods in marketing their product. It has been pointed out by correspondents that the unscrupulous marketing is chiefly due not to the producer but to various intermediaries between producer and consumer. The Engineering Record has again examined the data in hand and studied additional evidence offered since the editorial was published. It finds that it was in error in sweepingly attributing the unscrupulous practices to the producer. While there is evidence that the producers have at times been at fault, the trouble is more generally with the distributer. Investigation has further shown that much of the difficulty is due to the failure of the engineer's or architect's original specifications to reach the producer. They are altered in progress through several hands—contractor, retailer, wholesaler, broker. No matter where the blame should lie, however, branding at the source would cure the present evils. The chief point in mind in writing the editorial was the unsatisfactory condition of the present marketing of timber, and sufficient care was not taken to analyze information as to the party responsible for the present unsatisfactory practices.

Railroad Retrenchment

ANNOUNCEMENT by one after another of the Eastern trunk lines that it has laid off 15,000, 20,000 or even 25,000 men brings home the fact that whenever periods of depression come upon the railroads, whatever the causes, hardships befall a large number of employees. Lessened business can of course be met to some extent by reduction in operating and clerical forces and consolidation of duties at many points. Probably the most drastic cuts, however, are always made in the engineering departments. Maintenance can temporarily be cut to the bone without too great risk, and construction can be suspended almost entirely. Field men and draftsmen who have been in the service for years and have families to support are ruthlessly dropped on short notice, with scant chance of getting work in the same line when all roads are following a similar course. Many believe that more foresight on the part of railroad managers would impel them to balance their maintenance and construction programs with average conditions and not be compelled when hard times come to sacrifice men they have educated to their special problems. However that may be, there are few roads whose engineering forces do not fluctuate with business conditions. The thought of 100,000 or more men forced out of work through no fault of their own should make some impression on those who still think that a blow at the railroads strikes only the bloated bondholders. Evidently the Interstate Commerce Commission is beginning to appreciate the seriousness of the situation for it has announced that the rate hearing will be expedited. It is high time that the question be settled.

Conditions of Railway Employment

WHAT is wrong with the railway-engineering departments? The question is prompted by the numerous protests this journal hears from former railway engineers—both experienced and embryo. Generally the complaint is that the salaries are too low and that advancement is at a snail's pace. So numerous have been the complaints, and so widespread territorially, that it seems safe to conclude that the conditions are general in railway-engineering organizations. The result of the low pay and slow advancement is that very many of the more energetic young men leave before they become intensely interested in railroading.

While those who remain probably have as much ability as those who leave, the former are likely to be of a steadier temperament, more gifted technically than in ability to sell their services at a satisfactory figure. To conclude otherwise were to condemn railway organizations as a whole to mediocrity—a condition not borne out by an examination of the facts. Nevertheless, it may fairly be asked whether the salary policy of the average railway-engineering department does not result in a corps of lower average ability than is to be found in industrial and other private corporations. If it does, the policy is surely a short-sighted one, for while under present conditions the earnings of private corporations are not limited, those of quasi-public institutions are fixed by regulating commissions. While theoretically all expenditures will be allowed as operating expenses, thus covering up inefficiencies and making them negligible so far as dividends are concerned, actually competition plays a part in the net, so that the less efficient road stands in danger of being severely penalized if the performance of a more efficient road is taken as the basis for making the rate. Furthermore, when, as at present, the regulating commission does not act and the railways must run on too narrow a margin, the more efficient property stands the better chance of survival. Naturally the ability of the engineering department is translated into efficiency or inefficiency of expenditure, and the quality of the engineering personnel is, therefore, a factor in the general railway status. Although it is true that the engineering expenses are one of the minor ones in the railroad's total, it would be worth while to get more light on the quality of railway-engineering organizations and the conditions of service. The views of railway-engineering readers on this subject are, therefore, solicited for the "Letters to the Editor" column.

Governor Glynn's Discovery

GOVERNOR GLYNN of New York has made a discovery. It is that the State is engaged upon a road-building program that involves a staggering expenditure of money—a sum far in excess of the $100,000,000 of bonds already voted. As the Governor sums up the situation, the State's road system continued on present lines will cost $130,000,000 to build, $12,000,000 annually to maintain, and at the end of ten years from the completion of the work there will be little to show for an expenditure of $250,000,000. The 5-per cent road bonds run for fifty years. There is, therefore, an annual charge of $5,000,000 for interest and $2,500,000 for a sinking fund, in addition to the millions required for reconstruction and maintenance. A more exact and detailed analysis of the situation to which the Governor has now awakened was printed in the Engineering Record prior to the voting of New York's last $50,000,000 of road bonds. The unthinking variety of good-road sentiment, however, carried the proposal by a large plurality despite all protests.

On the theory that it is never too late to mend, Governor Glynn's financial diagnosis of New York's road-building malady is to be unreservedly commended, but his cure will require the careful study which any serious disorder naturally demands. The Governor has heard that other States are using convicts to make brick and thinks that New York's salvation can be secured by turning the State's penitentiaries into brick plants. By this means he believes he can cut down the cost of a brick road from $25,000 to $15,000 a mile. Where the Governor got these figures it would be interesting to know. He estimates the maintenance cost at $50 per mile per annum, a figure not unreasonable for a first-class cement-grouted brick road on a concrete base if surface only is considered and ditch, culvert and roadside maintenance are neglected—which, of course, should not be. The Governor is at sea, moreover, in figuring maintenance on all existing roads at $1000 per mile per year. The cost has reached this figure in some cases, but is far below this on that part of the bituminous-macadam system that was properly constructed. When, therefore, the Governor asserts that if his idea is carried out by the Legislature there will be a total saving on the 7300 miles of road yet to be built of $146,000,000 in twenty years, engineers may well question his conclusion, for certainly one of his unit figures is wrong, and others doubtful.

There is no disputing that New York should very carefully adapt types of construction to the particular traffic the roads are obliged to carry. If this were done there would be cheaper construction on some roads and more costly construction on others. It is as absurd to talk about building the entire road system of brick, despite its high merit, as it would be to consider building all of it of asphaltic macadam or cement concrete. Evidently the Governor's discovery of the possibility of using convicts in brickmaking has closed his eyes to every other consideration. He is to be congratulated, however, upon his awakening to the fact that the financing of New York's good-roads debauch is going to be followed by a very severe headache.

Tribute to an Engineer

NOT so long ago an editorial in the columns of this journal was headed, "Are Engineers Human?" To every one of the three hundred busy men who journeyed to Chicago two weeks ago from as far away as the two coasts to do honor to Ira Osborn Baker, civil engineer and teacher, completing forty years of continuous service at the University of Illinois, the question surely was answered in the affirmative. Few, if any, civil engineering gatherings have brought together so many of the leading engineers of the country. Ideals were set forth and broadminded men opened up visions of wonderful possibilities for the coming engineer, if he but acquire, in addition to his technical training, a broad outlook and wide sympathies. Human interest ran riot at the meeting. The trend of the addresses was reflected in the strong-set, serious looks, which those who study faces have learned to interpret as indicative of a harmonious audience controlled by the deeper emotions. In this frame of mind nothing is impossible to these men; the spirit of community service evidenced augurs much for our civic future.

Appreciation of the engineer by his professional brethren must come before the public can be expected to give unstinted praise. The greetings extended to Professor Baker by the principal civil engineering societies, both national and local, through their chief executives in person indicated that the profession has made a step forward in recognizing service well done.

In acknowledging the tribute paid him, Professor Baker, in a voice trembling with emotion, modestly directed attention to the time when his successor should be similarly honored, saying in closing: "I cannot wish him more happiness than I have in my work. I cannot wish him more joy than I have in the success of the men who have graduated under me. I cannot wish him more honor when he comes to lay down his work than a reception like this. I heartily pledge him my hearty and unlimited support." To those who know him nothing could be more typical of Professor Baker than these closing sentences.

Paving in London

SEVERAL matters of general interest appear in the eleventh annual report of the Metropolitan Paving Committee of London. The work of the committee itself is a good example of the possibilities of co-operation among highway authorities whose problems are essentially similar and who can give each other no little aid even if they are not organically connected. The report covers all work carried out in the various divisions of the County of London.

One striking feature of the report is the increasing thickness of concrete foundations. While we in this country have been getting up our courage and opening our pocketbooks to provide from 4 to 6 in. of concrete base for pavements and roads, London authorities have raised their standard from 6 to 9 in. and in several cases to 12 in. One particularly heavy traffic street in Holborn has been provided with a base of 14½ in. of concrete.

As to classes and kinds of pavement, soft wood block has been laid to a greater extent than any other surface. In only one section has there been any considerable amount of granite-sett pavement. It was for this pavement that the unusually thick concrete foundation was specified. To the abandonment of waterbound macadam in the Borough of Fulham in favor of bituminous macadam is attributed not only a great improvement in the highways so constructed, but a saving of $5,500 a year in the cost of cleaning the streets.

The report emphasizes again the superiority of foreign methods of laying wood block, which superiority is shown both in the better appearance of London's wood pavements and the figures for cost of maintenance. It is evident that the foreign practice of grouting the lower part of the block with pitch and flush-coating the top with cement much more than pays for the original investment. Merely dipping blocks in thick pitch for say half their lower distance and brooming the surface with thin Portland cement grout will add greatly to the life of any wood-block pavement for very little added cost. This practice is not new, but it is all the more remarkable for this reason that our city engineers have not followed the good example of countries where wood-block pavements are found at their best.

One other feature of the London report that calls for notice are the exact figures for cost of maintenance. These in many cases are figured out to a hundredth of a penny per yard repaired and on the total yardage under maintenance—another example that might be followed with good results by American municipalities.

Operation of Large Boilers

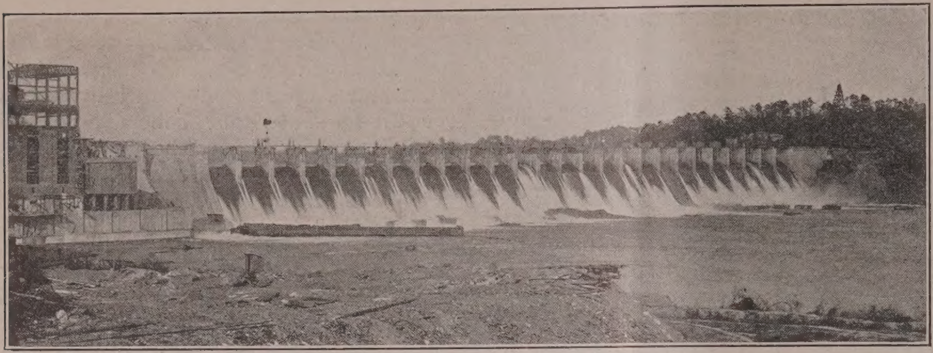
THE installation of a number of 2365-hp boilers at the Delray station of the Detroit Edison Company about three years ago set a new standard of capacity for the consideration of power-plant designers, and widespread interest has since been manifested in the performance of this equipment. In the February issue of the "Journal" of the American Society of Mechanical Engineers the operation of these boilers is discussed at length in a paper presented at the recent annual meeting of the society by J. W. Parker. The methods of handling these high-powered steam generating units, apart from the admirable efficiency records presented, are of much interest. They encourage the belief that plant owners interested in power production from fuel on a large scale are on the verge of a new era in the operation of boilers and auxiliary apparatus.

The labor requirements of boilers of the above-mentioned size are of great importance in relation to their operating economy. One man can control two such units with entire success if the plant is fully provided with auxiliary equipment which cuts down materially the amount of manual work required. Automatic stokers are a foregone conclusion in handling such units, and by driving these by variable-speed motors the fuel input can be closely adjusted to the steaming requirements. By the use of indicating dial tachometers on the stoker shafts the speed for a given load may be watched and overfeeding practically eliminated. Other essentials are a CO_2 recorder, steam gages showing the pressure at the superheater inlet and outlet, pilot steam gages for sensitive work near the safety-valve setting, draft gages showing the air pressure under the fire, draft at the damper and at the top of the combustion chamber, load indicators, and a centralized control for each boiler, from which the dampers are shifted and the throttles of the blower turbines opened and closed. The motor controllers for stoker service are also centralized, so that a minimum of time is lost in mechanical manipulation.

The supply of feed water for twelve such units can be handled by two water tenders. The author presents some significant figures as to the cost of firing twelve boilers, handling a maximum load of 120,000 kw and a minimum load of 20,000 kw, with a load factor of 46 per cent, twelve units being run at 191 per cent of their rating on the maximum output and four boilers at 96 per cent rating on the minimum. The morning shift of eight hours can be run by two head firemen at 45 cents per hour, six firemen at 40 cents, and two water tenders at 35 cents. The afternoon and evening shifts require the same organization, with the exception that in the latter case the head firemen are eliminated and only one water tender is needed. Including supervision by boiler-room foremen, the total cost of firing suc ha plant is 0.0076 cent per kilowatt-hour, and this figure represents a scale of wages within the plant which is a real incentive to painstaking work in the fireroom and capable of attracting a high grade of men to the service. The cost per day at the Delray station is 55 per cent as much as the firing cost in a neighboring manufacturer's plant equipped with twenty-four 278-hp water-tube boilers fired by overfeed stokers and furnished with economizers.

The flexibility of such units in handling variable loads is noteworthy. The efficiency curve as determined by Dr. D. S. Jacobus for the boiler and furnace of a Taylor stoker-fired outfit is a straight line from 93 per cent to 214 per cent of rating, ranging from 80 per cent in the former case to 76 per cent in the latter. It is therefore economical to run as many boilers as possible at about 90 per cent rating when the plant load is light and then carry the peak of the load by increasing the rating on the boilers. By such methods it is unnecessary to bank or break fires out of bank from morning until night, and sudden demands for steam can be met without difficulty. Based upon its experience with this size of boilers, the Detroit company will soon place in operation a plant to contain six 20,000-kw turbines to be served by twelve 2365-hp boilers, and it is possible to include no spares in such an installation because even if one boiler should go completely out of commission the others could be operated at 235 per cent of their rating. In fact, the settings and auxiliaries are being designed to allow continuous operation at 255 per cent of rating, which means that three boilers can carry the load of four, or 40,000 kw. More than 11,000 kw have recently been carried for an hour by one of these boilers without difficulty.

The author's discussion of the question of automatic control of water, fuel and air supplies, maintenance, reliability of service, and tendencies in furnace design will repay careful reading. The possibility of improving combustion conditions in the modern boiler plant is by no means confined to small installations. The prevention of smoke formation, reduction in steam-pressure drop in superheaters, and the strengthening of furnace wall construction, with increased avoidance of leaks under intense heat, all deserve thorough study. At present it looks as though the manual control of fuel, air and water, based in part upon instrumental indications and in part upon judgment, following close personal inspection of flame coloring and the appearance of the fuel bed, is likely to give better results with trained men than will dependance upon purely automatic apparatus. It is fortunate that the labor cost per unit of output is small enough in large boiler plants of this type to permit the permanent employment of the most skilled foremen, whose interest in the station performance far outweighs the value of ultra-automatic regulation. The labor cost of operating high-powered turbines is small under favorable load conditions, and it is doubly a cause for congratulation that the same advantageous conditions apply to very large boilers. The total unit cost of power in the new Detroit station, therefore, will be awaited with keen interest by engineers occupied with questions of fuel economy.



Downstream View of Coosa River Power Development at Lock 12

Building a 105,000-Horsepower Hydroelectric Plant in Record Time

Layout and Methods Employed in Construction of Coosa River Power Development at Lock 12 in Central Alabama

PLACING more than 175,000 cu. yd. of concrete in a gravity-section dam across a broad, swift river in less than eight months is an accomplishment even under the most favorable conditions. When the project is located in a broken, hilly and sparsely settled country 22 miles from a main-line railroad, when more than 90 per cent of the labor consists of the shifting type of Southern negro, when it is necessary to haul the sand, stone and gravel for the concrete from 8 to 40 miles, and when there are several other equally serious handicaps—this performance becomes the more noteworthy. It is under these conditions that such a record has been made in constructing the Coosa River power development of the Alabama Power Company in central Alabama, about 40 miles southeast of Birmingham.

Features of Project

THE Coosa River project is the first of a number of hydroelectric developments contemplated in Alabama by the company. At the site of the plant the stream is about 1150 ft. wide and has a flow ranging from 2000 to 120,000 sec.-ft. The dam and the power house, including the wing walls at the ends, have a total length of approximately 1650 ft., of which the spillway section is 930 ft. between abutments. The power house is 128 x 324 ft. and rises 163 ft. above the bottom of the tailrace excavation. The top of the spillway is 70 ft. above the bottom of the cutoff trench at the heel of the dam. Above the crest the water level is controlled by twenty-five steel gates on rollers. Between the spillway and the power house is a wasteway, the three sluices of which are designed to pass 40 per cent of the low-water flow of the stream at all times. The power-house substructure has been built to provide for the installation of six 17,500-hp main units, four of which are being installed at present.

Details of the plant are shown in the accompanying illustration. The waterwheels were built and are being installed under the direction of the I. P. Morris Company, of Philadelphia. The electrical equipment has been designed and is being manufactured by the Westinghouse Electric & Manufacturing Company.

Installation of the construction plant was started in August, 1912. The site is 22 miles from the main line of the Louisville & Nashville Railroad, and it was expected that an old logging railroad could be utilized and extended so that rail connection could soon be had. The railroad, however, which had been built with switchbacks, 5-per cent grades and curves as sharp as 28 deg., and had long been abandoned, required complete rehabilitation, including the rebuilding of forty-two trestles. It also had to be extended 4 miles, and a large amount of switch and auxiliary track at the plant had to be built. The line was not completed until December, 1912, and no concrete was placed until April, 1913.

Complete organization of the railroad operating forces has overcome these handicaps to such an extent that the work at the dam has progressed without hindrance on account of the delivery of materials and supplies. Some idea of the results of this railroad organization may be judged from the fact that as many as 300 train orders have been issued in a single day, and during one month 5576 cars were handled over the line.

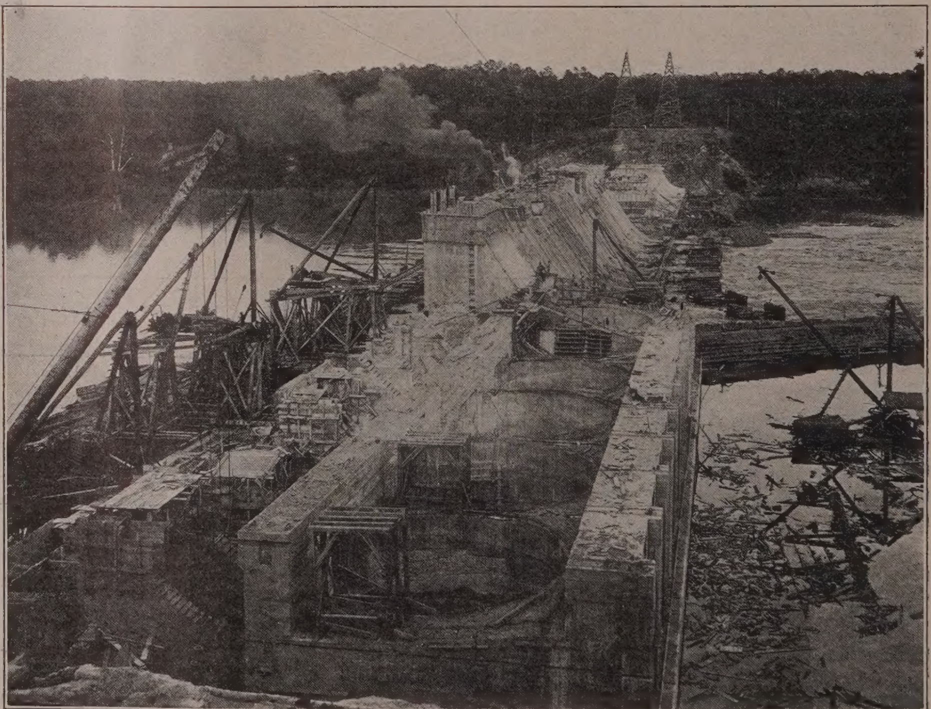
Five Shay geared locomotives and nine rod engines have been used on the work. The latter have been utilized at both ends of the line and on a 2-mile branch leading to a quarry. The Shay engines have handled the bulk of the traffic over the steep grades. Throughout much of the length of the line it was possible to pull only two loaded cars. Passing tracks at close intervals have permitted trains of from four to six cars to be operated by pushing two cars at a time up the steep grades.

Cofferdams

AS soon as the preliminary work of providing the camp was partly completed, placing of the heavy construction plant was started. Meanwhile work was under way on a cofferdam which inclosed the site of the power house, the adjacent wasteway section and 447.5 ft. of the spillway section. The upstream side of this cofferdam was 714 ft. long and was located 40 ft. above the upstream face of the spillway. The side cribs were built up in part on the shore, floated out to place and sunk in position. They were then cross-connected by the upper transverse timbers. Meanwhile the sheet piling was placed and the rock deposited in two side pockets to anchor the cribs in position. Following this the middle pocket was filled with clay puddled through the water. The double-lap sheet piling on the upstream side prevented any flow of water through the cribs. Two additional rows of double-lap sheet piling kept the earth in place and prevented wash. After the cribs were completed and filled they were floored over to prevent material being scoured out of them during floods which would top them. This type of cofferdam has proved satisfactory under the conditions encountered.

Excavation

EXCAVATION necessary to prepare the site of the dam for concrete was comparatively slight, owing to the satisfactory character of the stream bed. A total of about 38,000 cu. yd. of rock was removed within the cofferdams. Little difficulty was encountered except where a peculiar pocket



Substructure of Power House with Large Wheel Pits was found hollowed out in the bottom of the stream close to the west bank. This pocket, which was filled with earth, gravel and boulders, finally had to be excavated to a total depth of 55 ft. and filled with concrete.

The trench in which the cutoff wall of the dam was built was started by channeling along both edges. After this strip had been drilled the rock was loosened by blasting and removed by derricks or cableways. The remainder of the rock excavation, outside of the power house and tailrace, consisted chiefly in cleaning off the loose surface and broken ledges to a depth of from 2 to 8 ft.

Spoil from the power-house and tailrace excavations was loaded into small dump cars, which were handled over a system of incline tracks leading to a waste bank downstream from the site. These cars were operated in trains over these inclines by means of a hoisting engine.

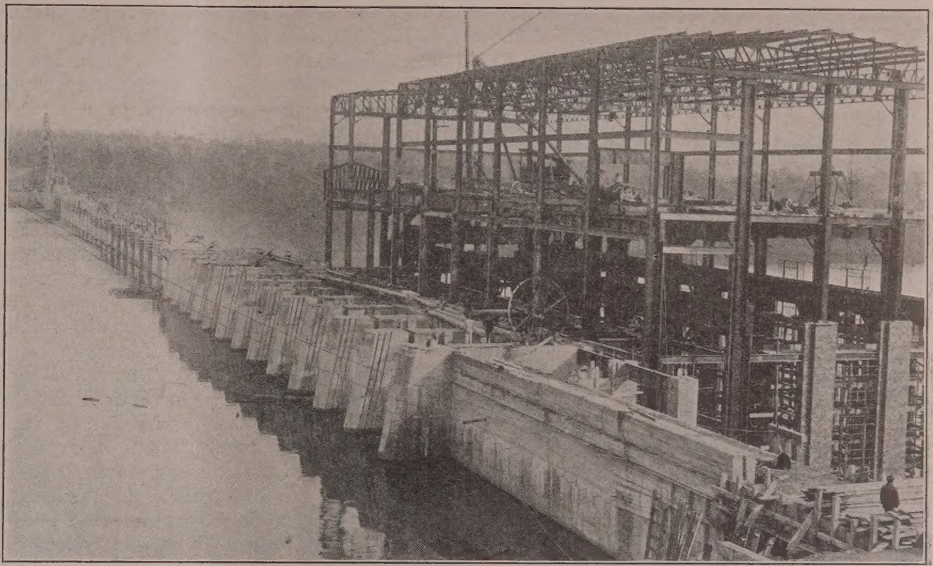
Practically no difficulty was occasioned from water within the cofferdams. An irregularity in the rock bottom of the river at one point caused a leak which it was difficult to close, so two 10-in. centrifugal pumps were installed. These handled what little seepage there was.

Quarry

All sand and gravel and about 25 per cent of the broken stone used in the concrete were obtained from outside sources along the main line of the Louisville & Nashville Railroad. The remainder of the broken stone, amounting to about 136,000 cu. yd., has been secured from a quarry, with crushing, screening and storage plant, opened up especially for this work. The latter was located 7.5 miles from the concrete-mixing plant. Before the work was started investigations indicated that a suitable supply of stone for concrete could be secured a short distance from the site. The distant quarry, however, had to be developed, and as the ledge uncovered dipped badly the quarry was operated with much difficulty.

To reduce costs to a minimum the quarry was operated to full capacity at all times. A storage capacity of 2300 cu. yd. was provided by bins erected in connection with the crushers. When a bin was filled and the crushers were producing faster than stone was needed, the excess was stored in piles.

The concrete-mixing plant is located on the west bank immediately downstream from the axis of the dam. This plant contains two 2-yd. Ransome concrete mixers set high enough to deliver into 2½-yd. buckets on flat cars. Power to operate both mixers is furnished by an 80-hp engine belted to a jackshaft. A friction clutch is provided for each of the mixers, so the latter may be operated independently.

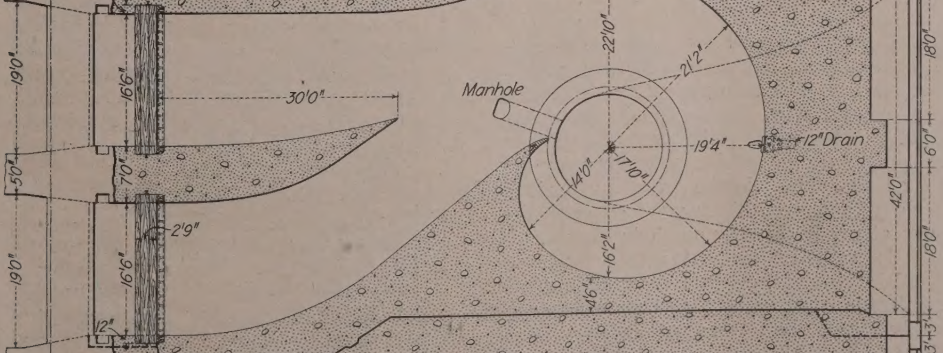

Upstream View of Dam and Power House from West Bank

Concrete Aggregates

Cement, sand, gravel and broken stone used in the concrete were delivered to the site over the railroad. The concrete plant was located on a bench cut in the bank of the river, making it possible to build a switch track paralleling the stream at a sufficient elevation to take full advantage of the gravity handling of the materials.

Cement was unloaded from the cars into a storage shed having a capacity of 4800 bbl. From this shed, or directly from the cars, the cément could be shot down an incline to a charging floor over the mixers. In addition to this, 15,000 bbl. were stored in a shed ¼ mile from the dam.

A storage hopper built up immediately adjacent to the mixing plant provided a capacity of 1250 cu. yd. of sand, gravel and broken stone. This hopper was located immediately downstream from the mixing plant and at an elevation permitting the delivery of the material to it by gravity from bottom dump railroad cars on the siding paralleling the plant. Twenty outlet openings along the side of the inclined bottom of the hopper provided means of drawing sand, gravel and broken stone at will from the several compartments into which the hopper was divided. Through these openings, each of which was controlled by a quick-acting hand-operated gate, the materials were delivered to an Austin horizontal belt conveyor. This conveyor discharged into the boot of a 30-in. bucket elevator, 67 ft. between centers of pulleys. At the top this elevator delivered into one of three bins holding 125 yd.—one for sand and two for rock—directly over the mixers. The materials were drawn from these bins into measuring hoppers, from which the mixers were charged directly.



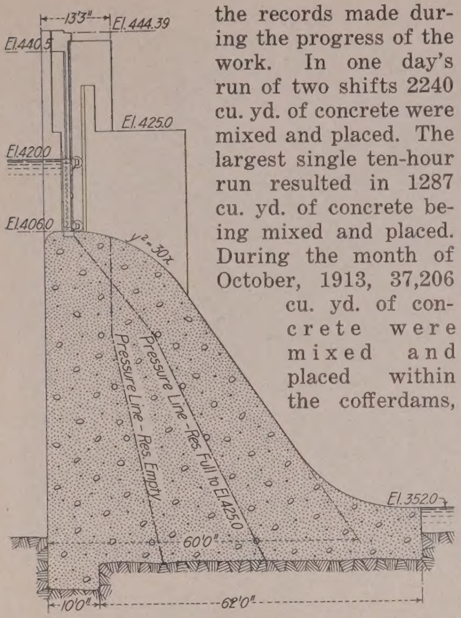
Plan of Wheel Chamber for 17,500-Horsepower, Single-Runner Turbine

Cableways

Two cableways of 1608-ft. span have handled most of the concrete for the dam and substructure of the power house. These cableways have each a 2¼-in. lock-bar Leschen standing line and are rigged with Hercules wire rope. The 2½-yd. Stuebner controllable center-dump buckets into which the mixers discharged were hauled a short distance on narrow-gage flat cars out under the cableways. A simple system of tracks over which these cars operated eliminated all switches. The buckets were lifted from the cars, carried out and lowered to place by the cableways.

Chutes were extended from the concrete-mixing plant down the side of the river bank to tracks on the same level as the top of the cofferdam. Concrete was thus delivered to buckets on cars at this lower level and then hauled out to within the range of nine traveling stiffleg derricks, which handled the buckets. As the height of the work increased, trestles carrying the derricks were raised accordingly. Standard dimensions and fittings were adopted for the nine traveling derricks, which were all equipped with American Hoist & Derrick Company fittings. This standardization reduced the amount of extra parts necessary and otherwise simplified the use of the derricks.

The combination of cableways, chutes and traveling derricks made it possible to take the concrete away from the mixers as fast as they could produce it. Some idea of the speed attained may be judged from



Cross-Section of Spillway Dam

the records made during the progress of the work. In one day's run of two shifts 2240 cu. yd. of concrete were mixed and placed. The largest single ten-hour run resulted in 1287 cu. yd. of concrete being mixed and placed. During the month of October, 1913, 37,206 cu. yd. of concrete were mixed and placed within the cofferdams, as well as much of the 55,000 cu. yd. of concrete used on the power house.

Handling of River

THE general method of handling the work on the dam was to build first the cofferdam extending out from the west shore. The substructure of the power house and the portion of the spillway section inclosed by this cofferdam were then carried practically to their full height. The three large wasteway openings and the eleven 15 x 16-ft. stream-control openings were left temporarily in the spillway section to handle the flow of the stream while the remainder of the spillway was being built. Next a cofferdam was built out 190 ft. from the east bank and the spillway section carried up within it in a similar manner. This left an opening 285 ft. wide between the two cofferdams. Through this opening the flow of the stream was handled until the section of the spillway in the west cofferdam was up high enough to pass the stream through the eleven stream-control openings and the three permanent wasteways. Before the closing cofferdam was started the stream was diverted through the stream-control openings, thus reducing the current in which the final cofferdam work had to be handled.

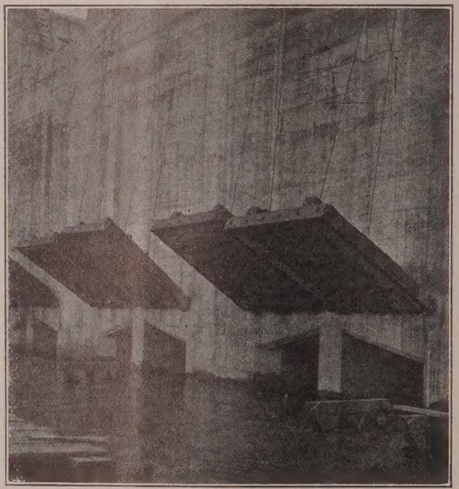
As originally planned, the section of the spillway to be built in the closing cofferdam was to be left low enough during the progress of the work to handle exceptional floods across it. This plan was changed later by providing ten additional stream-control openings through this final section. These openings were each 8 x 12 ft., with inverts practically at the same elevation as the tops of the eleven openings in the first section of the spillway built. As a matter of fact the water only rose once to this second set of stream-control openings, and it was possible to complete the entire dam without passing any water over the structure.

Concrete Work on Dam

THE spillway was built in sections, either 72 or 108 ft. long, parallel to the axis, the length of these sections being determined by the spacing of the piers on the crest of the dam and of the stream-control openings. The sections were carried up so as to leave a distinct joint between them. The face of the concrete at the joints was heavily painted with hot pitch to insure a tight connection and to prevent a bond. The mass concrete consisted of a 1:3:6 mixture, using broken stone which would pass a 3-in. ring. On account of the difficulty of obtaining cyclopean stone of good size, and of the manner in which the placing of such stone hindered the work, the total amount of large stone used was less than 3 per cent of the volume of concrete required.

Concrete in the spillway sections in which the work was handled was generally carried up to a height of about 5 ft. at a time. By working on three or four sections simultaneously it was possible to handle the forms in such a manner that no delay was occasioned. When work was started again on a concrete surface which had hardened, wire brooms were used to remove all loose material and laitance which had collected, and where necessary dilute acid was also used.

When the spillway section was completed and the power-house section had been carried to a sufficient height, arrangements were made for closing the stream-control openings through the spillway section. The eleven main openings in the first section of the spillway as constructed were divided by a longitudinal wall into two openings of equal width. At the upper ends of five of these openings stoplog grooves were provided so the openings could be closed simply by dropping a gate of heavy timbers into place. The remaining six and all of the second set at the higher elevation were closed by a simple flap gate swung from hinges embedded in the concrete.



Stream-Control Culverts and Gates

Flap Gates

THE flap gates used in closing the stream-control openings were provided with a bearing face consisting of strips of felt 6 in. wide and 1 in. thick, tacked around the edges. After these gates were hung they were held up by cables extending to the top of the dam. When the time arrived to close them the cables were cut and the gates allowed to swing on their hinges. It was found that the gates thus released would hit the water hard, slow up in passing through the water until they were practically closed, and then seat with a rush. The felt facings on the gate gave a tight seat, so that practically no leakage occurred through any of the openings.

Leakage through the openings closed by the stoplogs was comparatively slight. To insure a tight closing of the openings with concrete, special means were adopted to handle the leakage. A bulkhead was built inside the opening and about 8 in. from the stoplog gate, closing the latter. Two 3-in. pipes connected the space between the stoplog gate and the bulkhead with the downstream face of the dam. The leakage through the stoplogs was carried by one of these pipes until the opening through the dam was filled with concrete. Grout could then be pumped through one of the 3-in. pipes until the space between the stoplogs and bulkhead was filled. Issue of grout from the second pipe, which was level with the top of the space, indicated when this space was filled.

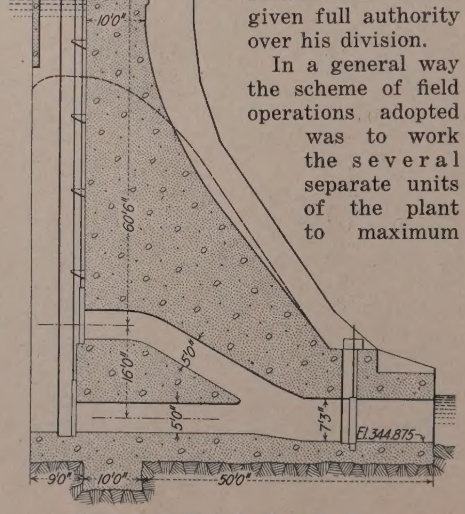
Power to operate most of the construction equipment at the dam has been supplied by a steam plant on the west bank directly below the concrete mixing plant. Four hand-fired 125-hp locomotive-type boilers were installed here. They furnished steam directly to the engines operating the mixers and the conveyor system of the storage plant.

Two Ingersoll-Sergeant single-stage air compressors, each having a capacity of 1248 cu. ft. of free air per minute, were installed in the power plant. These supplied power to operate the tripod rock drills, the hoisting engines on the traveling derricks and several other hoisting engines located at various points. Air-driven small tools, including boring machines and similar equipment, were also supplied by these compressors. Cableways and pumping plants were operated by individual boilers.

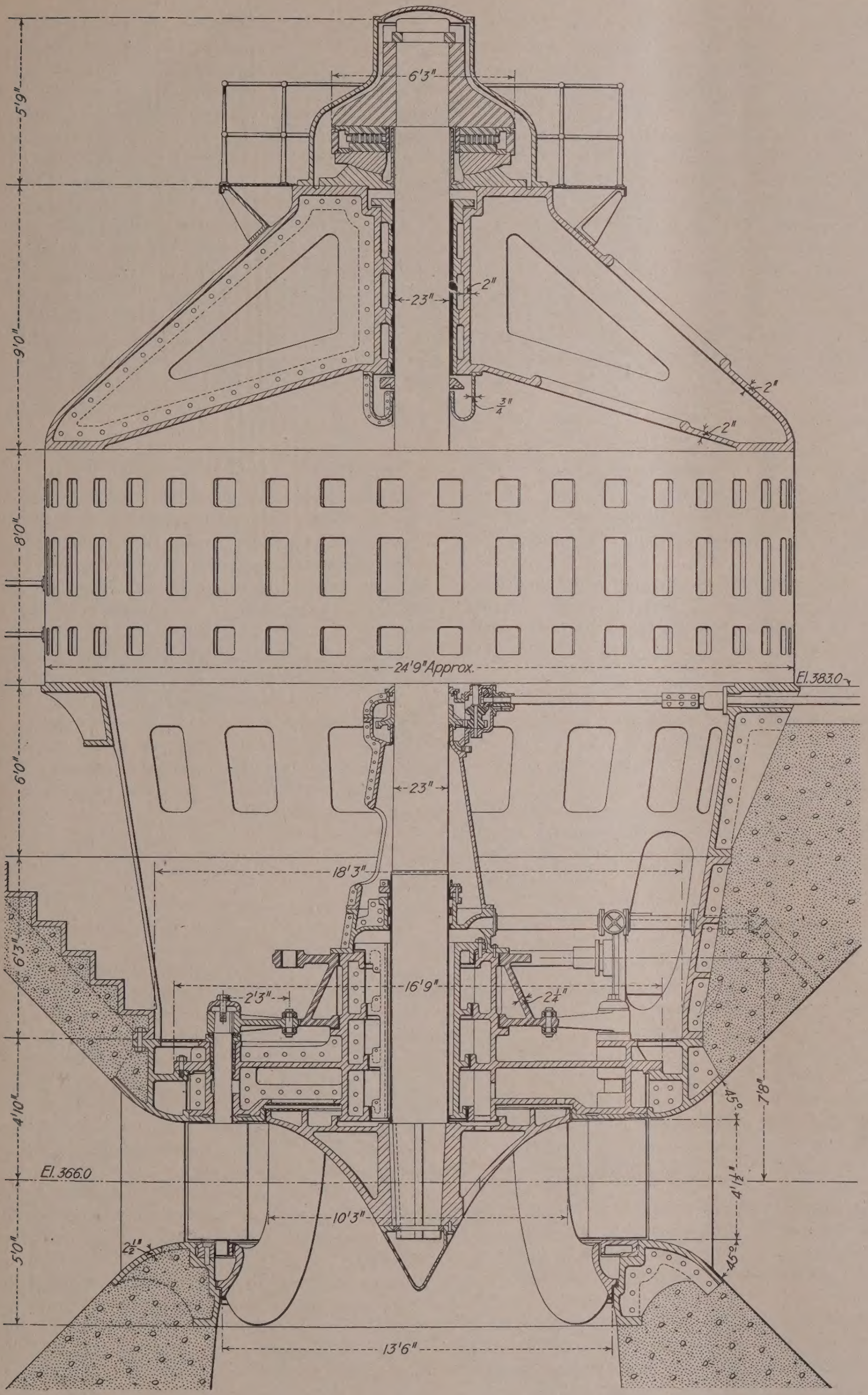
Organization

TWO features developed in building this project were the organization of the field construction forces and the general scheme of operations followed. In the first place, the field superintendent was made entirely responsible for the progress and results obtained. He in turn separated the work into several divisions. The branch railroad was one division, the quarry and crushing plant was a second, operations directly in connection with dam and power house a third, organization and sanitation of the camp a fourth and accounting and office management a fifth. Each division was under the charge of an assistant superintendent, who was responsible for the work under his direction and was given full authority over his division.

In a general way the scheme of field operations adopted was to work the several separate units of the plant to maximum



Section of Sluices through Dam



Elevation of 17,500-Horsepower Turbine Operating under 68-Foot Head

capacity, regardless of the progress being made on other parts of the job. For instance, the operation of the quarry and rock-crushing plant went ahead continuously, as has been noted, even though their output had to be stocked temporarily. In the same way, materials were brought in over the railroad as fast as they could be shipped. This plan resulted in tying up some capital for a short time, but the charge on this was entirely offset by the saving in time of construction thus secured.

The Alabama Power Company has been financed largely by English capitalists. J. W. Worthington is president and the operations in the field are being conducted under his general supervision. E. A. Yates is chief engineer and A. C. Polk resident engineer in charge of construction.

The contract for the construction of the Coosa River power development, exclusive of the power-house superstructure, was awarded to the MacArthur Brothers Company, of New York, Chicago and San Francisco. Most of the plant machinery was furnished by the U. S. Equipment Company, of Chicago. George H. Penglase, as superintendent for the contractor, has had entire charge of the installation of the construction plant, the development of the organization and the execution of the work.

NEW YORK'S LUMBER CONSUMPTION for the past year amounted to more than $54,000,000, placing it ahead of all other States in this regard. The Empire State owns one-fifth of the forest land within its borders.

Financing Water-Supply Extensions for Centralia, Illinois

Method Applied in Securing Quickly $5000 Stock Subscriptions for $158,000 Project

FIVE years ago citizens of Centralia, Ill., were called together in a mass meeting by the chief executive and on them was unloaded the water problem. Constitutional limitations prevented the raising of sufficient funds by the city council. The methods of financing were described on March 10 by C. D. Tufts, president of the Centralia Water Supply Company, before the Illinois Water Supply Association. From this paper the following notes have been taken.

Twenty years ago the city took over a pumping plant of the Illinois Central Railroad located on Crooked Creek, 2 miles north of the city, and established a city waterworks. The creek from which the water was derived became polluted and entirely inadequate to supply the city's needs. Following the appointment of a citizens' committee of seven, with full authority to devise and carry into execution plans to provide an adequate water supply, the method of financing the extension to the supply which was adopted some time before at Mattoon, Ill., was chosen. Prof. G. C. Habermeyer of the University of Illinois recommended a site 8 miles above the existing pumping station for a dam. E. F. Harper, of East St. Louis, reported that a dam 800 ft. long and 30 ft. high would impound a body of water 24 ft. deep at the dam and have a capacity of 1,000,000,000 gal. and a watershed to conserve the water from an area of 8 sq. miles. A spillway 150 ft. in length was provided, and about 8 miles of 20-in. wood conduit following the creek bottom brought the estimated cost to about $125,000.

STOCK COMPANY ORGANIZED

A STOCK company was organized, capitalized at $150,000, and an agreement entered into with the city council on the terms of a contract under which the city obligated itself to lease and operate the reservoir and pipe line and to purchase them at their exact cost. The revenues of the water department were pledged to pay 6 per cent interest on the amount expended, and the city also obligated itself to issue $50,000 in bonds in part payment of the purchase price and to issue $10,000 of new bonds each year so as to make an annual payment on the balance. The contract further provided that the city was to levy $10,000 in general taxes each year to pay off that much of the original issue of bonds, so that the original amount of $50,000 stands with $10,000 paid off and $10,000 issued each year. This roundabout method was necessary on account of the legal limitations as to issuance of bonds and taxation.

Methods of getting the money following this agreement between the city council and the company were carried out by the committee calling on the president of the two banks and making out a list of prospects, setting opposite each person's name an amount that in the combined judgment of the committee and the bankers he could afford to subscribe. The banks consented to take the notes of these persons without other security than the company could furnish. The plan was to ask them to subscribe certain sums to the capital stock of the company and to assure them that the company would obtain the money on their notes without calling on them to do more than sign. The shares of stock signed for were deposited with the banks as collateral security and the banks furnished the money necessary for the construction.

HOW SUBSCRIBERS WERE OBTAINED

THE list of names started with $5000, and from that on down to $1000. No subscription was taken for less than $1000. The lists were made up one Saturday afternoon and the chairman of the committee announced that the capital stock must all be subscribed the following week. If he had said the reservoir must be constructed the following week the other committeemen would not have had any greater doubt as to his sanity, but they forebore calling a sanity commission and went to work.

On Monday afternoon the newspapers contained leading articles explaining and encouraging the project and carried at the head in good-sized type the names of those who had subscribed $5000—not how much each man had subscribed, but the names of those who had subscribed $5000. Only those of the $5000 list were called on for the first three days, and anything less than $5000 was refused. Each day the names of all who had subscribed this amount were published with a story of the progress of the campaign. The method was so effective that before the committee had finished with the $5000 list several who were on for less sums voluntarily came forward and signed for $5000. On Wednesday the committee was obliged to lay off on account of a funeral, but on Thursday night eighteen $5000 subscriptions had been obtained. By that time the ground had been broken for quick work on the men of lesser means, and when the enthusiasts quit work Friday night $133,500 had been subscribed, which at that time was considered sufficient. There were fewer than forty subscribers. The committee undertook all the responsibility, the mental, moral and financial hazard of financing and constructing a project which finally cost $158,000, and no officer or director of the company received a dollar of compensation either directly or indirectly. Even the lawyers in the company gave their professional services without charge, and it is significant that if lawyers are working without compensation it is rarely necessary to go to court, inasmuch as every acre of land required for the pipe line right-of-way and every other necessary settlement was secured without litigation.

BONDS

THE bond brokers would not take the bonds issued by the city in part payment on the contract, on the ground that no such transaction had ever run the gantlet of the Supreme Court. The company took the bonds and held them in its treasury as assets for security of its stockholders and the banks that had loaned money on their notes. After the work was completed and accepted by the city the local banks took the bonds and credited the $50,000 on the stockholders' loans.

Construction of the dam and pipe line was completed in time to catch the spring rains of 1911. The water has a natural fall of about 25 ft., besides the depth in the basin, which carries it by gravity through 20-in. wood pipes to the pumping station, from which it is delivered directly to consumers. A small reservoir near the old station is used as a reserve and at times is drawn upon after heavy rains have increased the turbidity of the water in the large reservoir. Much trouble was encountered with leakage at the start.

The next step will be to add to the system a filter plant, which is greatly desired by the water consumers. The mayor and the city council strongly favor the installation of an approved filter plant, but so far the money is not available, as the compelling spirit of "we must" has not yet taken possession of the people as regards the filtration of the supply.

Concrete Specifications in Detroit Building Code

Amendments Passed March 17 Relative to Columns and Girderless Flat-Slab Floors

MARCH 17 the Detroit city council amended that part of its building code relating to concrete building and block construction. Some of the provisions are given below.

For columns reinforced with longitudinal bars tied at intervals not greater than twelve times the least diameter of the bars the safe load shall be computed as follows:

Safe load (in pounds) = 550 ($A_c + 12 A_s$), where A_c = net cross-section of column in square inches, and A_s = cross-section of longitudinal reinforcement in square inches.

For columns reinforced with longitudinal steel and with spirally wound hooping the safe load shall be computed as follows:

Safe load (in pounds) = 650 [$A_c + 12 (A_s + 2.4 A_h)$], where A_c = net cross-section of concrete enclosed in hooping, A_s = net cross-section of longitudinal reinforcement (not to exceed 8 per cent of A_c) and $A_h = 3.14\, d\, a/p$, where d and p = respectively diameter and pitch of hoop in inches and a = cross-sectional area in square inches of wire or rod forming hoop—provided that A_h shall not be less than 0.5 per cent nor more than 1.5 per cent of A_c, and that p shall not be more than one-tenth the diameter of hoop nor more than 3 in.

FLAT SLAB FLOORS

GIRDERLESS flat-slab floors reinforced in either two or four directions and supported by enlarged column capitals may be constructed according to the following principles: It is assumed that w = total dead and live load per square foot; l, length of one side of panel if square or larger dimension, measured from center to center of columns, if rectangular; B, shorter dimension of rectangular panel measured from center to center of columns; L, side of square having same diagonal as $B\ l$ (in a square panel it equals l); D, diameter of column capital at a point where it is at least 1½ in. thick, and K, bending-moment coefficient having the values hereinafter defined. Then D must not be less than 0.225 L and the sides of the column capital must not slope at an angle with the perpendicular of more than 45 deg., provided that if the slab is increased in thickness around the capital the diameter of the capital may be reduced by one and one-half times the thickness of such drop. Also, l must not be more than 1.25 B.

For slabs reinforced in four directions, the steel in the center of the panel shall be designed to resist a bending moment of $w\, l^3/25$ for interior and $w\, l^2/22$ for exterior panels. The steel so determined shall be divided equally among two diagonal and two cross bands for square panels, and in the case of rectangular panels one-half of this steel shall be equally divided between the diagonal bands and the remainder between the cross bands in proportion to the cubes of their lengths.

The negative bending moment in 180 deg. around the column capital, that is, the negative moment resisted by two diagonal and two cross bands at the supports, shall be taken as $wl^3/15$.

To compute the concrete stress at the column capital a negative bending moment of $wl^3/25$ shall be assumed to be resisted by a band of concrete not wider than D plus six times the slab thickness, nor wider than the sunken panel or drop if such is used, nor wider than 0.4 l.

REINFORCED IN TWO DIRECTIONS ONLY

FOR slabs reinforced in two directions only the bending moments in each direction shall be calculated by dividing the slab into eight equal strips starting from the center line of two columns. Each strip shall be regarded as a continuous beam having a positive bending moment at the center and a negative bending moment at the line of supports. The bending moment at each of these points shall be $wl^3/8\ K$ for square panels and $w\ l^2 B/8K$ in the direction of l and $w\ B^2\ l/8\ K$ in the direction of B for rectangular panels. K shall be for interior panels as follows, starting at the center line of columns:

	At line of supports	At center
First strip................	—13	+26
Second strip..............	—19	+38
Third and fourth strips, each	—58	+58

For exterior panels these values are to be decreased 20 per cent. Compressive stresses in concrete are to be calculated by assuming that the entire width of each strip resists the bending moment assigned to it.

If desired that portion of the slab lying between column capitals may be regarded as a continuous girder and the central portion of the plate as a slab reinforced in two ways and supported on all four sides.

That portion considered as a girder shall not be wider than the column capital plus six times the thickness of the slab nor wider than 0.5l.

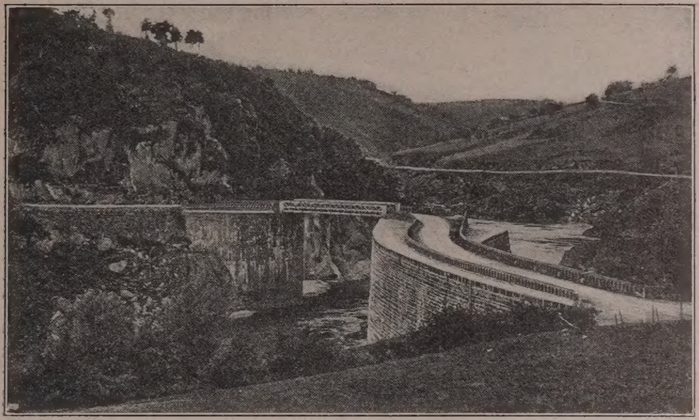
The negative bending moment at the support and the positive bending moment at the center shall each be taken as $w\ l\ s^2/24$ where s is clear span in direction of girder and l is distance between column centers at right angles to girder.

The remainder of the slab shall be known as the inclosed panel and shall be bounded by lines parallel to lines of center of columns and at a distance from edge of column capitals not greater than two and one-half times the thickness of the slab.

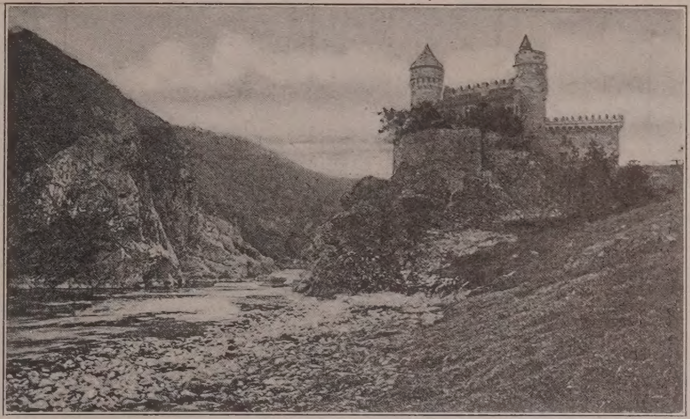
The bending moment at each edge of the inclosed panel shall be taken as $w\ p^3/24$ and at the center as $w\ p^3/36$ in each direction where p is the side of the square for square panels and is the side of an equivalent square for rectangular panels.

No flat slab shall have a thickness at the center of less than $l/32$ for floors nor less than $l/35$ for roofs.

When the slab near the column capital is increased in thickness so as to form a sunken (or raised) panel or drop the dimensions of this drop shall be not less than 0.375 times the panel length in the same direction.



View of Pinay Dam from Upstream Side



Restricted Waterway at La Roche Dam

"Dry" Reservoirs in France

As Early as 1711 Two of These Were in Operation in the Loire River to Prevent Floods

By KENNETH C. GRANT
Dayton, Ohio

ABOVE the city of Roanne, on the Upper Loire River, in central France, there are two interesting examples of the "dry" reservoir method of flood prevention which have been in operation since 1711, when they were ordered built by government edict.

About 12 miles above Roanne the narrow, rocky gorge of the Loire is further restricted by a heavy masonry barrier, leaving a vertical slot or channel opening in the streamway only 64.5 ft. wide. The crest of this barrier is about 72 ft. above the stream bed; the other dimensions are as shown in the accompanying sketch.

The country above this gorge widens out into the immense flat plain of Forez. In great floods the water backs up behind this barrier, and only a limited amount is able to flow through. The flood spreads out over the plain and a large part of the damaging discharge is thus temporarily stored. The low country above is prepared to receive these occasional overflows without damage, and the farmlands are greatly enriched by the fertilizing silt which is deposited.

RESERVOIR ON THE UPPER LOIRE

AT a similar gorge along the Upper Loire, not far above Roanne, a similar flood barrier is formed by the Château de Saint-Priest-la-Roche and a heavy masonry dam or causeway, which together completely obstruct the flood channel, except for the narrow rocky streamway only about 69 ft. wide. The general arrangement and dimensions of this flood barrier are shown in the drawing.

The Upper Loire drains a steep, mountainous country of heavy rainfall and impervious surface. The runoff is high and rapid and floods are frequent and severe. These two "dry" reservoirs have repeatedly saved the city of Roanne from annihilation during the last two centuries.

EFFECT ON FLOODS

IN the flood of 1846 the water stood 9.5 ft. higher above the Pinay dam than below it, and a big volume of water was thus stored on the flat country above. In October, 1855, a great flood backed up behind this dam to its full height. It thus temporarily stored 3,530,000,000 cu. ft., and the rise at Roanne had attained its greatest height before the basin behind the dam was completely filled. The flood discharge at Roanne would have been 88,000 sec. ft. greater if the dam had not been in existence. In the great flood of 1856, for 16½ hours an average of 64,500 sec.-ft. and a maximum of 127,000 sec.-ft. were thus held back, or a total volume of about 3,831,000,000 cu. ft.

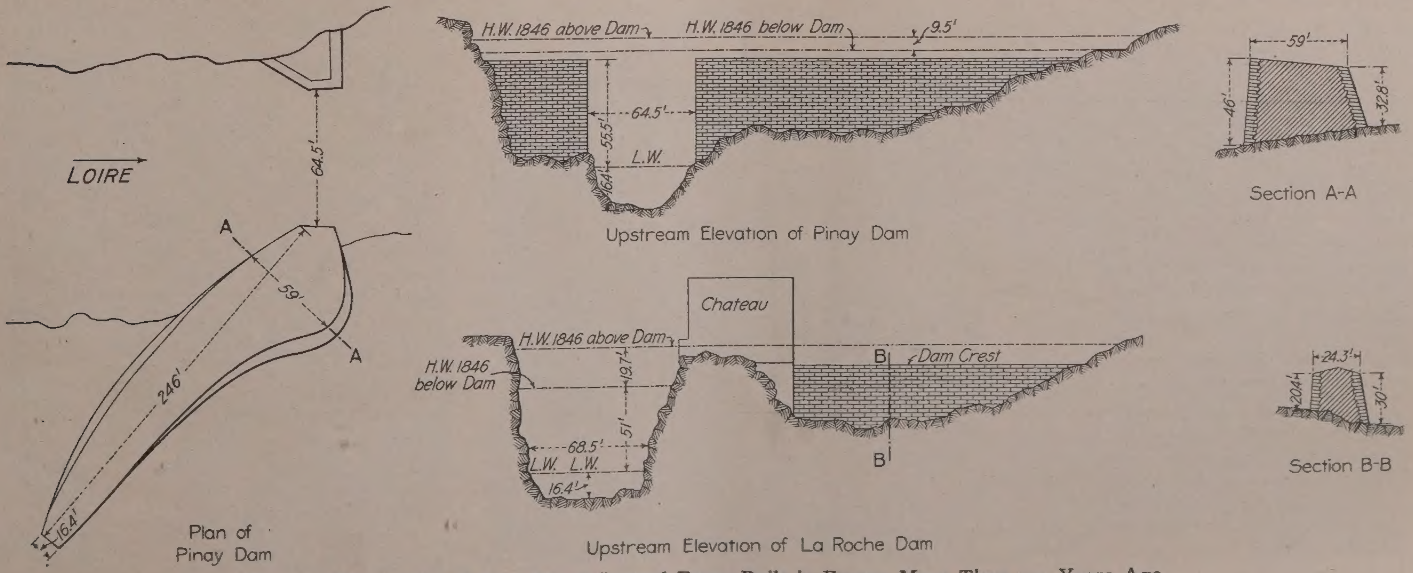
At Saint-Priest-la-Roche, in the 1846 flood, the water stood 19.7 ft. higher above than below the flood barrier, and a large volume of the damaging part of the flood was thus stored.

The retaining action of these two dams or barriers has prevented coincidence of the floods in the Loire and the Allier, its greatest tributary, which joins it about 100 miles below Roanne, at the city of Nevers. The Allier has a shorter and steeper course than the Upper Loire and collects and sends out its floods in advance of those of the latter. These two dams further delay the floods in the Upper Loire and let the Allier floods pass out first. Obviously, similar works on the Allier would have been dangerous, and have never been built.

Auto-Truck Fender Ordinance in Detroit Repealed

REPEAL of the auto-truck fender ordinance in Detroit was effected March 3. The reasons given in the minority committee report of the city council are that the auto-truck owners were forced to use fenders utterly inadequate for the purpose, and that on account of the non-appearance of a fender in the market that has all-around merit it is impracticable to enforce their use. Opponents to the repeal of the ordinance believed that "safety first" should be the predominating feature in the regulation of street traffic and that loss of life had been minimized by the ordinance.

IN DREDGING the Columbia River bar channel the scraper-suction dredge "Columbia" is reported to be handling sand at a cost to the Government of 2½ cents per cubic yard.



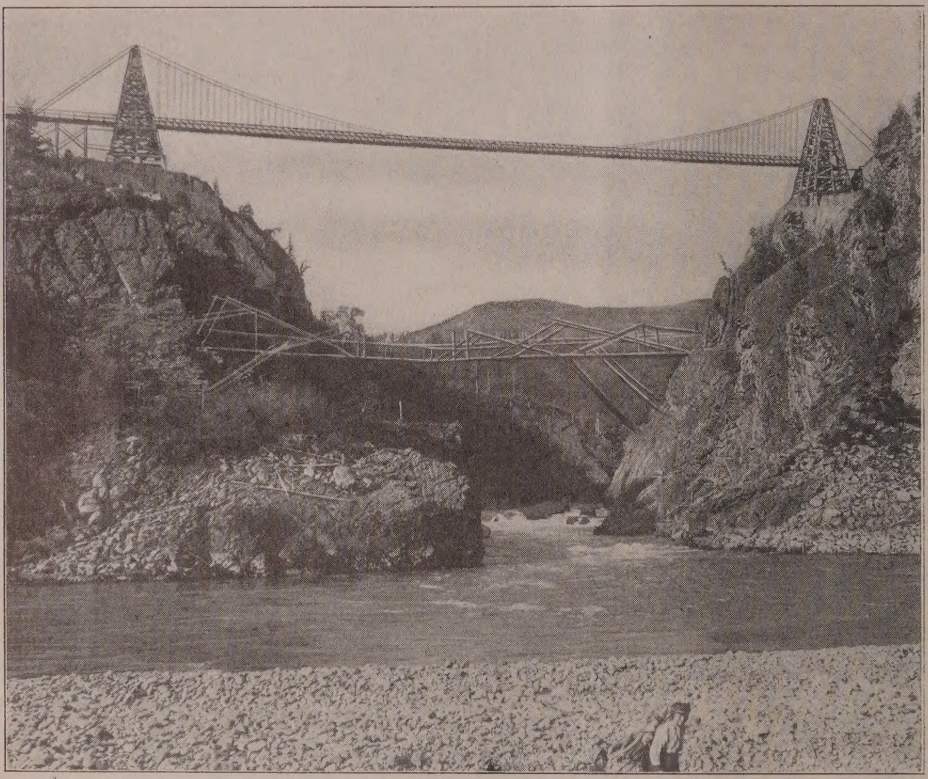
General Dimensions of Two Flood-Control Dams Built in France More Than 200 Years Ago

Two Picturesque Bridges

A Suspension Span Recently Built over a Canadian Gorge, and Beneath It a Primitive Structure Made by the Indians

By FRANK C. PERKINS

A STRIKING contrast is presented between two bridges over the Bulkley River in northwestern Canada on the direct route to Klondike—one a suspension bridge recently designed by Wire Rope Manufacturers & Engineers, of Wakefield, England, and the other, almost underneath the first, an old structure built by the Indians. Both are shown in the accompanying illustration.


New Suspension Bridge and Old Structure Built by Indians

The new bridge is of the stiffened suspension type provided with stiffening girders, which minimize undulations and serve as side railings. The wood towers, which are 451 ft. apart, are 68 ft. high and reach 47 ft. above the floor level, which is 250 ft. above the river. The main cables, 2 7/16 in. in diameter, are made of improved plow steel, and each has a tensile strength of more than 300 tons. Both vehicular and pedestrian traffic is accommodated, hundreds of square miles being served by the bridge.

The Indian structure is the third of its kind, two earlier ones having been washed away by the turbulent waters of the river. As an example of native ingenuity the bridge is especially interesting for the reason that not one nail was employed, wooden pegs being used to fasten the members together.

ELECTRIFICATION of the Norwegian Government railroads is the subject of a newly submitted report by a special commission. The excessive prices of imported coal (Norway having no coal mines) led to the investigation of the feasibility of using "white coal," and the electrification of seven trunk lines at a cost of $9,000,000 is recommended.

Supply and Marketing of Pine Timber

Observations Based on an Inspection Trip through the Timber Districts of Louisiana, Texas, Mississippi and Alabama

DISCUSSION precipitated by a paper presented by F. J. Hoxie before the American Society of Mechanical Engineers has been going on in this journal for some time. Mr. Hoxie, returning recently from a trip through certain timber districts of the South, has rendered a report to the Associated Factory Mutual Fire Insurance Companies, for which he is engineer and special inspector, which throw light on certain phases of the subject. The following paragraphs are selected from various sections of the report:

In the course of my recent trip through the South I met the manufacturers of a large proportion of the hard-pine lumber produced in the South. I also visited nine large sawmills in Louisiana, Texas, Mississippi and Alabama, and inspected several lumber yards and several long-leaf pine forests from which large trees suitable for manufacturing mill timber are being taken.

I found, in all cases, short-leaf pine growing in the same forests with long-leaf and cut by the same mills, which tends to disprove the statement of a well-known authority that the place of origin of timber, as shown by the bill of lading, serves as a suitable safeguard. I found plants of the dry-rot fungus growing about several lumber yards visited.

ABUNDANCE OF LONG-LEAF PINE

I FOUND it evident that there is an abundance of long-leaf pine of suitable sizes for mill timbers which can be had at reasonable prices. It remains to make specifications clearly defining the qualities required when a bill of timber for a cotton mill, or other important structure, is sent out by the designing engineer or architect to be sure of getting not only long-leaf pine but long-leaf pine that is strong and durable. Evidence of the inadequacy of the specifications now in common use is plain in many ways.

The need of more definite specifications for mill timbers and columns, I find, is appreciated by the lumber manufacturers as well as by the engineers. Many examples were given by the manufacturers where lumber bought as short leaf had been sold by middlemen as "long leaf," of "merchantable" sold as prime and of "square edge" sold as merchantable. The remedy which has been suggested for this condition is that lumber manufacturers clearly mark their timber with its variety, grade and the name of the manufacturer.

The lower grade of timber, called "square edge and sound," does not pretend to be long leaf pine. All varieties (long leaf, short leaf, Cuban and loblolly) are manufactured indiscriminately into this grade. Its durability cannot be depended upon without antiseptic treatment.

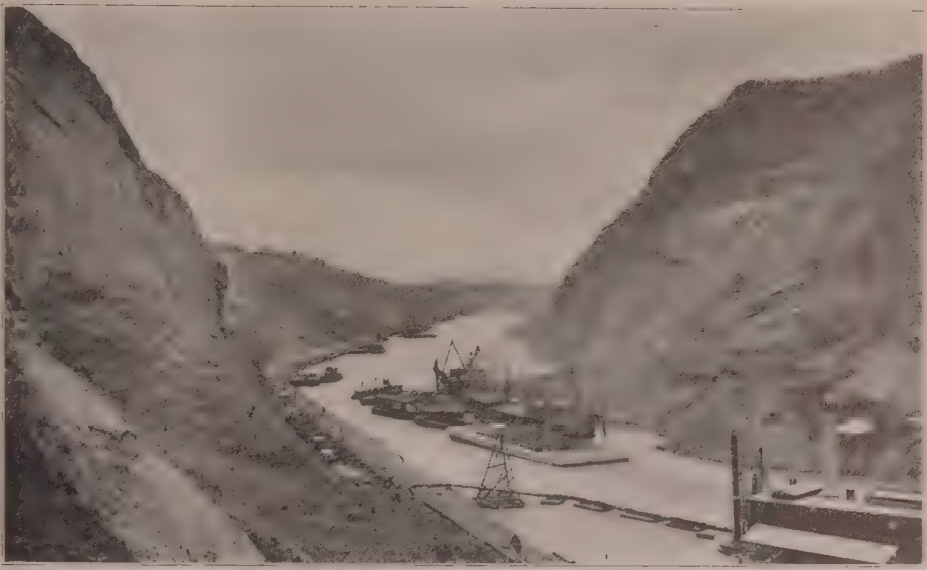
MIXING VARIOUS GRADES

SOMETIMES short leaf and loblolly become mixed with the better grades, and cannot be told apart by careful surface inspection, and even by microscopic examination they cannot be positively distinguished. At one mill visited a pile of columns was noted which had been cut to size and bored for use in mill construction. Most of them were good, but one was apparently short leaf pine and plainly of poor quality. This practice of mixing varieties of similar superficial appearance, but of widely different strength and durability, which is made legitimate by the present specifications of the American Society for Testing Materials, is most unfortunate for all concerned.

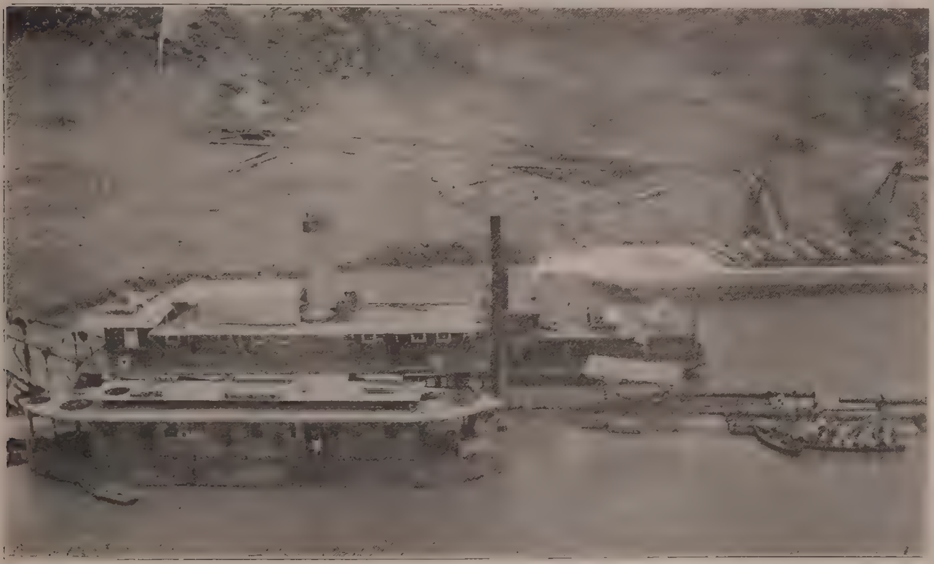
Much of the best quality of long leaf pine grown in the South is being shipped to Europe. At many of the mills visited I was shown the best material under the name of "German prime 30 average," which means that the timber must be practically all heart wood, the average volume to be 30 cu. ft. per stick. This is found advantageous to the lumber manufacturers, as they are not held down to uniform sizes and can get the largest possible amount of timber out of each log. This material is sold at from about $30 to $40 per thousand at the mill.

I was told by several of the lumber manufacturers that they hardly considered it worth while to estimate on specifications calling for "merchantable long leaf pine," as the higher price of the true long leaf pine, when in competition with short leaf and loblolly, made it impossible for them to quote prices at which they could sell their goods, where price only was considered, as is frequently the case with the American buyers. The export trade gives more consideration to quality and is willing to pay a higher price for better material. This is a fact well worth consideration by the builder of a mill when he buys timber at $27 or $28 per thousand, with $10 freight and handling charges between him and the Southern sawmills. The apparent cheapness entirely disappears, if it is found necessary to remove a considerable amount of this material on account of rot, within a few years.

It is apparent that fineness of grain can no more be taken as a final criterion in selecting long leaf timber than can the location from which it is shipped. Frequently the same tree varies enormously in the fineness of grain between the top and the bottom or from the center to the outside. In many cases the long leaf pine shows a coarser grain than the short leaf, as previously noted. It is evident that something far more reliable than the fineness of grain bands is necessary, not only for identifying long leaf pine and distinguishing it from short leaf, loblolly or Cuban pine, but as an index of strength and durability.


Dredging Plant at Work on Cucuracha Slide, Culebra Cut

I have previously stated that hard pine 12 in. square and larger is not obtainable with sufficient natural resistance to withstand fungus in a moist atmosphere. This statement is based upon examinations of rotted timber received from many different mills within the past few years, and certainly continues to hold so long as present methods of selling and inspecting mill timber are continued. If good and bad timber are to be mixed at the sawmill, or by the middleman, the only safe course is to give all timber antiseptic treatment. If reliable timber can be kept by itself, or tests can be devised by which it can be surely identified, it may be safe to continue to use such assuredly reliable material without chemical treatment.


Dredge in Foreground; Hydraulic Giant on Hill Above

Branding and Listing

It is suggested that financially responsible lumber manufacturers who own timber land containing at least 100,000,000 ft. of large long leaf pine trees capable of yielding 12 x 16 merchantable timber, and who can furnish at least five hundred 12 x 16 merchantable long leaf pine beams 25 ft. long on thirty days' notice, send at least six samples of such timber of full cross-section of beam and 6 in. long to the laboratories of the Associated Factory Mutual Fire Insurance Companies, and that upon receipt of these samples and assurance of the lumber manufacturers' ability to fulfill the above requirements, their names be listed by the mutual companies in their circular relative to factory timbers, in a similar manner to that now in use for the names of manufacturers of tanks, automatic sprinklers and electrical appliances.

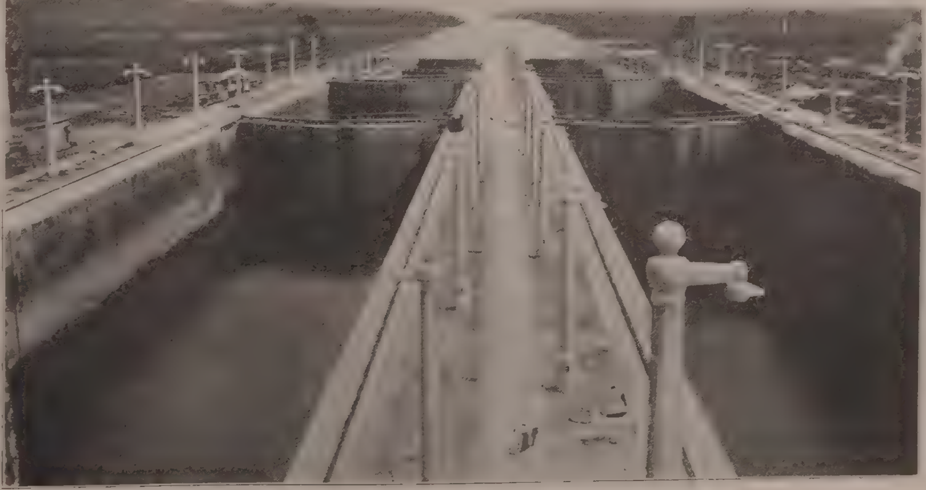
This listing should be conditioned upon an agreement of three manufacturers to clearly mark their timber with their name, grade, and botanical variety, the name "long leaf pine" being used only for the Pinus Palustris, the mutual companies to make inspection of the mills and timber lands from time to time to assure themselves that the requirements are being met.

Lumber, such as columns, beams and heavy floor plank, supplied for important factory construction should be inspected and samples examined to determine density and durability. Ultimately chemical and physical specifications should be developed upon which to base more reliable grading. Antiseptic treatment should also be studied.

Progress at Panama

Herewith are presented three views showing the status of the Culebra Cut and the Gatun Locks on the Panama Canal. One of the views shows the larger part of the plant at work on the removal of the Cucuracha slide. In the foreground are dipper dredges, and in the lower right-hand corner is one of the suction dredges. Another picture shows a suction dredge in the foreground and on the hill above a hydraulic giant removing the overburden. The material washed down is discharged into the scow tied up at the bank on the right-hand side.

The third view shows how nearly completed, from external appearances at least, are the locks at Gatun. The photographs were taken Feb. 20 by Arnold von Schrenk, of New York.


Gatun Locks Practically Completed February 20, 1914

Railroad-Yard Lighting

Needs at Track Scales and Classification Units, and Advantages and Disadvantages of Various Lighting Systems

ONE of the differences in modern yard design from that of earlier years is the attention given to proper lighting. Especially where cars are pushed in rapid succession night and day over a hump and track scale and classified by gravity is it recognized that both safety and economy demand that weighers, switchmen and car riders be able to see clearly at all times. These notes, therefore, taken from a paper presented by H. Kirschberg and A. C. Cotton at a recent meeting of the Pittsburgh section of the Illuminating Engineering Society, should be of interest to designers of yards.

TRACK SCALES

OF the many special problems of illumination presented on a railroad none perhaps is of more importance, from a railroad viewpoint, or capable of more solutions than that of track-scale lighting. Where the scales are located on a hump the train is pushed from the receiving yard to the hump, where each car is cut from the train and allowed to run by gravity down a sharp grade to and over the scale, thence down a lighter grade to the classification yard. As the car passes over the scale at a speed of about 2.5 miles per hour the weighing is done. In addition to the weighing, the number and light weight of the car are read from either the ends or sides of the car, and recorded on the weighmaster's manifests. The entire operation takes from eight to twelve seconds. It is also necessary to see under the car to a certain extent, in order to determine whether the car is entirely on or partly off the scale. The conditions to be met in the lighting of the location are as follows:

1. There must be sufficient illumination in the scale house, with special attention to the scale beam in the bay window, to permit rapid and accurate weighing. At the same time the lamps should be so placed and shielded that none is in the field of vision from either the inside or the outside of the scale house, and that no reflection of the lamps, making it very difficult to see numbers on the cars outside, is seen in the windows. If interior lamps are visible from the outside, the glare may be sufficient to prevent good vision around the hump and clearance grades, so resulting in possible accident to riders and car cutters.

2. There must be sufficient illumination outside the scale house to permit safe cutting of cars at the hump, location of the car at every point in its movement, and clear sight of movement of every wheel on the scale; reading of light weights and numbers on ends of approaching cars, or on side of car while on the scale, or on the receding end of car, if not procured during either of the two aforementioned intervals; movement of wheels off the scale, clear sight of movement of car down the clearance grade in order safely to pass the next car over the scale, and location of position of car on the clearance grade in order not to bump the cars too hard when making up drafts to go down the classification yard.

The weighmaster must, in order to work, look from a well-lighted room into an illuminated open space with a dark background. The riders are continually moving from a well-lighted zone into one with a very low intensity of illumination. Glare in such cases is productive not only of danger to individuals but also of possible damage to equipment and loss of time and money. It would not be correct to use the general-yard lighting system for lighting the exterior, for the reason that light is needed at the scale some time before the yard lighting is necessary. All scale lamps should, therefore, be on a separate control. With the low height of roof, the small roof overhang, and the narrow space between the side of the car and the scale-house window, the problem of placing units of large enough capacity and sufficiently low intrinsic brilliancy to do the work is not a very simple proposition. The outside lamps should by no means be visible to the weighmaster. The location of the neighboring lighting units will affect the efficiency of the scale-lighting installation, hence a study of local conditions for each scale is necessary.

In the classification yard the usual lighting scheme employs a line of arcs down the center of the yard and a line on each side. Other methods have also been used, with as poor results, but being improvements over still poorer original methods they have been voted successes. There should be illumination of (1) the grade leading from the scale to the yard, (2) the switches at the head of the yard to facilitate control of car movement from the switch tower, (3) every track, irrespective of the position of adjacent cars, and (4) every car in the yard. There must also be absence of glare from every position in the yard. These requirements must be accomplished without the retention of too much space from trackage.

LIGHTING SYSTEMS

MANY different lighting systems have been employed, among which may be mentioned the following, with some of their advantages and disadvantages as viewed from an up-to-date standpoint, and in the light of the latest developments in lighting units:

Series alternating-current inclosed carbon arc lamps have the advantage of simplicity and easy control, but the disadvantages of poor power factor, low efficiency, poor distribution of light and the necessity for reflectors. Series direct-current inclosed carbon arc lamps have the same advantages, with better distribution of light. They have a low efficiency and high maintenance cost when compared with the latest series-arc systems, however, and require converting apparatus in an alternating-current plant or for a Brush arc machine.

Flaming arc lamps may be connected in either series or multiple, and have the added advantages of long trim, high efficiency, low maintenance cost based on flux of light produced, and good distribution. They tend to flicker, however, and require extraordinary attention. Arc projector lamps have simple control, but their numerous disadvantages include objectionable glare, limited area illuminated, necessity for constant attendance and excessive cost of maintenance.

Luminous arc lamps have all the advantages of series systems in general, with good distribution of light, high efficiency, long trim, reliability and low-maintenance cost based on flux of light produced. They require converting apparatus in an alternating-current plant or for a Brush arc machine.

Series tungsten lamps have all advantages of series systems, with good efficiency and almost ideal distribution if correctly installed and used in small units. They use either the direct or the alternating current. If small units are used, the initial cost of installation is high, and reflectors are necessary to obtain the desired distribution and overcome the glare due to the low height of the lamps.

Quartz lamps have the advantages of steadiness, high efficiency, good distribution for high mounting, good color value for outdoor illumination and a large flux of light. This, due to light distribution of the unit, can be used to good advantage by high mounting and large spacing. Their disadvantages are that they require direct current, are in multiple unit only, and give wide variation in candlepower with variation in temperature. There is also at present a lack of data as to reliability of operation and length of life of the burners.

Italian Government Builds Water-Power Plants

CONSTRUCTION of two hydroelectric installations, providing for power and irrigation, has been undertaken by the Italian Government. One of these is estimated to cost about $5,000,000, involving the erection of a dam 175 ft. high across the River Tirso, in Sardinia. The quantity of water impounded will be 11,654,000,000 cu. ft., and 10,000 hp will be available for electric energy in the Cagliari mines. There will be approximately a total of 50,000 acres to irrigate.

The other work, which is of much greater magnitude and serves three power houses, is on the mainland, at the sole of the boot-shaped kingdom. There, on the plateau of Silas, from 4200 to 6200 ft. above the sea level, will be three reservoirs, with embankments 131, 95, and 203 ft. high, impounding 5,500,000,000, 2,000,000,000 and 600,000,000 cu. ft. respectively. Two of these reservoirs are connected by a channel, 17,500 ft. long, and the combined waters are led through a rock channel, 14,200 ft. long, to a penstock chamber, 4000 ft. above sea. The upper power house is 2000 ft. below this, and will receive a supply also from the third reservoir through a 23,000 ft. channel, with a fall of 385 ft. From this point 3000 ft. of channel, partly in tunnel, leads to the middle power house with a fall of 1288 ft. From the middle power house a 6500 ft. channel leads with a fall of 329 ft. to the third power house, from which the water will pass into the Nito River and irrigate a triangular district of which the distance from base to apex is 15 miles. The 200,000 hp developed will be used for metallurgical operations and other industries. The cost is estimated at from $12,500,000 to $15,000,000.

ESCAPING WATER, as recounted in the Engineering Record of March 14, 1914, page 304, undermined a building in Springfield, Mass. Attention has been called to the fact that the title of the article and that of the cut were in error in attributing the trouble to a broken water main. The article distinctly says that the main was intact. The break was undoubtedly on the hydrant line, but since neither the hydrant nor the hydrant connection has been found the cause is not known. The error is due to inaccuracy on the part of the headline writer.

Improvement of Chislett Street, Pittsburgh

Method of Supporting a Street over an Earth Slide by Using a Special Reinforced-Concrete Retaining Wall and Platform

By N. S. SPRAGUE

Superintendent, Bureau of Construction, Pittsburgh

A DESIGN both interesting and unique of a reinforced-concrete retaining wall has recently been completed at Pittsburgh in connection with repairs to Chislett Street, which had settled to such an extent as to make it dangerous for traffic. The street is located along, and some distance above, a ravine and at the location of the wall crossed a lateral ravine. In 1896 the street was improved to a width of 50 ft. It has two 10-ft. sidewalks and a 30-ft. roadway paved with sheet asphalt. A single street-railway track is located in the center of the street.

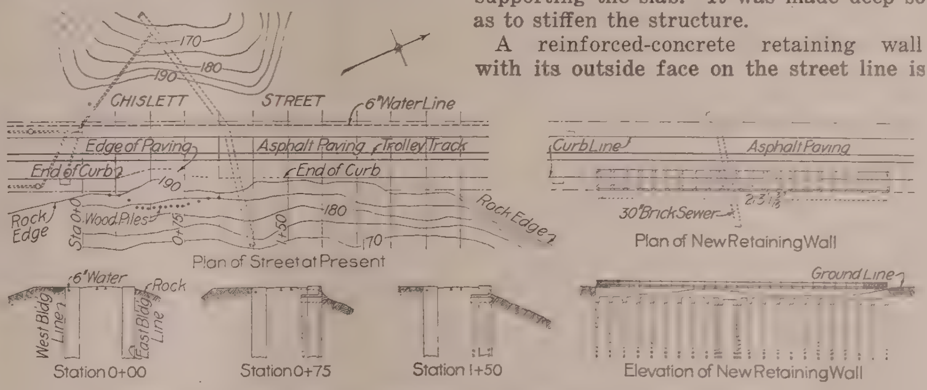
Prior to the original improvement there was an unimproved roadway in the lateral ravine extending from the hillside to the main valley. A portion of the old road where it crossed Chislett Street was built upon an embankment. It also appears that rock had been quarried along the hillside of the main ravine and in the lateral ravine close to the easterly street line. The quarry working evidently extended a distance of about 300 ft. along the street and to a depth of about 50 ft. below the present curb grade.

ORIGINAL CONSTRUCTION AND DISPLACEMENT

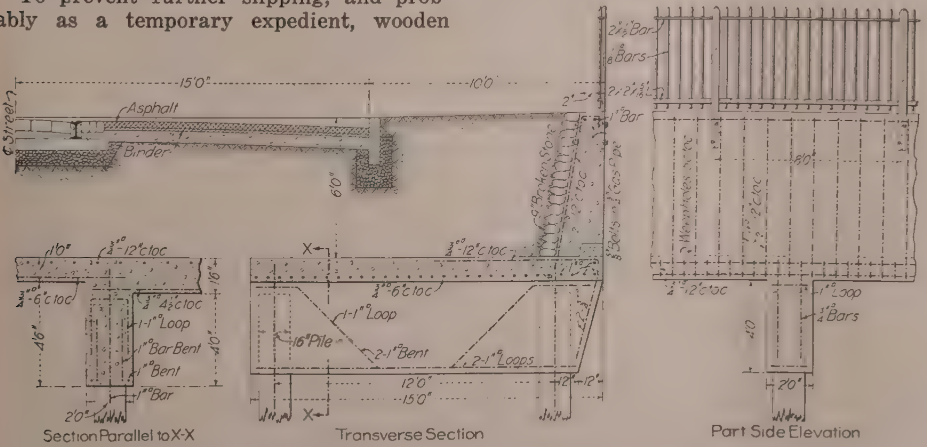
AT the time of construction a large quantity of filling was required to form the embankment on the hillside of Haights Run hollow and to carry the street across the lateral ravine. The depth of fill at the deepest point of the lateral ravine was from 45 to 50 ft. The sidehill fill extended about 180 ft. from the east line of the street to the thread of Haights Run on a slope of 2 to 1. The material used in making the fill was of mixed character, containing large quantities of clay.

A 30-in. circular brick sewer following the line of the lateral ravine crosses the street at a depth of about 39 ft. below the present curb grade. During the building of the embankment considerable difficulty, it is stated, was encountered due to the movement of the slopes, but the filling was continued until the required grades and lines were reached. It is possible that leakage from the sewer or water in the trench following the line of the sewer contributed to the slipping of the embankment.

To prevent further slipping, and probably as a temporary expedient, wooden piles were driven and anchored by steel rods to the roadway. This construction proved ineffectual; the piles, pushed out of line and gradually decaying, permitted the embankment to slide, which carried away a section of the easterly sidewalk and damaged the roadway for a length of about 80 ft. The movement extended to the street-car track, which settled vertically and moved laterally nearly a foot. The slope continued to move slowly for a number of years until the condition of the street became dangerous for traffic. While the traffic on the street is not extensive, it is constantly increasing with the development of the district.



Retaining Wall, General Sections of Roadway, Plan and Profile



Typical Construction and Details of Retaining Wall and Foundations

ALTERNATIVE REMEDIES

CONSIDERING the depth necessary to secure a suitable foundation and the length of the slope in motion, the problem was to devise a scheme which would be effectual and not prohibitive in cost when compared with the benefits derived. It was obvious that a retaining wall of the usual type would have to be carried to great depth at excessive cost. Stripping and benching of the slope and filling out to the street lines, together with the construction of a toe wall, were then considered, but the large quantity of filling required and the poor character of the underlying embankment caused the rejection of this scheme.

Since it was reasonably certain that the movement of the embankment was due to the sliding of a surface layer of the slope, it was decided to adopt a construction which would support the street and be independent of any movement of the ground.

The adopted construction, as shown on the accompanying plans, consists of two rows of concrete piles, 12 ft. apart, driven into firm ground, the easterly row being 2 ft. from the street line. These piles are driven in bents, generally 10 ft. apart on centers, except where the construction had to be modified in order to avoid the existing sewer. These bents carry a reinforced-concrete girder 4 ft. in depth and 2 ft. in thickness, upon which is supported a reinforced-concrete slab 12 in. in thickness, reinforced with ¾-in. bars on the tension side, spaced 4½ in. on centers. The girder was designed to serve the double purpose of securely anchoring the piles together to take the horizontal earth thrust and of supporting the slab. It was made deep so as to stiffen the structure.

A reinforced-concrete retaining wall with its outside face on the street line is anchored into and carried on the concrete slab. The extremities of the concrete slab at the ends of the wall are anchored to the rock, thus providing an additional factor of safety against possible movement of the structure. The light reinforced retaining wall carried on the slab is 6 ft. 2½ in. high, with a top thickness of 12 in. and a bottom thickness of 24 in., and is reinforced with ½-in. square bars spaced 12 in. apart. It carries a picket fence.

The specifications required the use of concrete piles, suitably reinforced, either molded in place or on the ground. The safe working load specified per pile was 30 tons.

Construction was begun Aug. 27, 1913, and the work was completed Dec. 8, 1913. The concrete piles used were of the Simplex type, 16 in. in diameter, with a 1-in. bonding rod extending the full depth of the pile, which was carried up into the concrete slab. The piles were driven to an average depth of 40 ft. from point of cutoff.

COSTS

THE total cost of the structure and repairs to the pavement was $9,982.50, the cost of the structure proper being $8,526.73. The principal items of work and the unit costs and quantities were as follows:

Excavation, 956 cu. yd., at	$1.25
Reinforced concrete, 306. cu. yd., at	7.50
Steel reinforcement, 27,900 lb., at	.05
Concrete piles, 1819 lin. ft., at	1.80
Iron picket fence, 213 lin. ft., at	1.75

The contractor for the work was the M. O'Herron Company, of Pittsburgh. The work was under the supervision of the Bureau of Construction, of which T. M. Reed is division engineer.

Design of Elevated Water Tanks

Analysis of Loads and Stresses in Flat, Spherical, Elliptical and Conical Bottoms and Typical Solution for 100,000-Gallon Tank

By CHARLES S. PILLSBURY
Engineer, Chicago Bridge & Iron Works

IN the following discussion it is intended to give the correct method for determining the stresses in the bottoms of elevated water tanks of the different types in common use. Except in the case of flat-bottom tanks, each formula gives the stress in pounds per linear inch. To get the net thickness of plate required, divide by the unit stress, and then select the proper gross plate thickness and riveting to give the required net section.

The stress in the plates of a flat-bottom tank is not exactly determinate, but is approximately as follows (see Slocum and Hancock, "Strength of Materials," page 143):

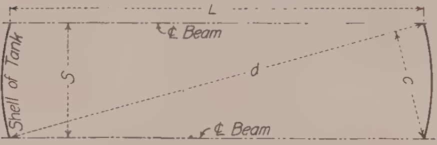


Fig. 1

Maximum fiber stress is

$$pC^2/2t^2 \text{ lb. per square inch} \qquad (1)$$

where C = length in inches of the perpendicular to d (Fig. 1); t = thickness of plate in inches; and p = unit pressure in pounds per square inch.

This formula, which is derived mathematically by assuming the dangerous section along d, is intended for use only where the length does not exceed two or three times the spacing of the beams. According to results of experiments made by T. A. Bryson published in a bulletin of the Rensselaer Polytechnic Institute, the stress in flat plates supported on the edges—(Fig. 1) where the length of the beams L is about ten times the spacing S—is:

Maximum fiber stress is

$$0.6\, pS^2/t^2 \text{ per square inch} \qquad (2)$$

Note that if the plate is considered as a simple beam the formula would be:

Maximum fiber stress is

$$0.75\, pS^2/t^2 \text{ per square inch} \qquad (3)$$

In applying the above formulæ the outside beam should be about 0.8 S from the circumference of the tank shell. It will then be proper to take for S the distance between the flanges instead of the distance center to center of the I-beams.

SUSPENDED BOTTOM

Stress in Joint Cut by Horizontal Plane.—In Fig. 2 assume a horizontal plane A-A passed through the tank bottom at any point. Use the following symbols: r = radius in inches of the section cut by the plane A-A; θ = angle tangent at the point A makes with the vertical; W = total load, including water and metal supported by that part of the bottom below A-A, and T = stress per inch of circumference,

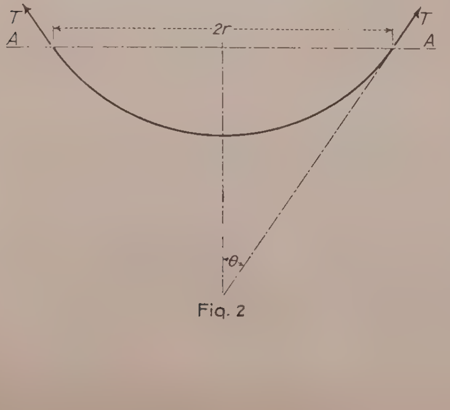


Fig. 2

$$T = W \sec\theta/2\,\pi r \text{ lb. per linear inch.} \qquad (4)$$

Note that r is not the radius of curvature.

This formula applies to any suspended tank bottom. Should the bottom be partially supported by the tank riser the actual stress is less than indicated by formula (4).

Stress in a Joint Cut by a Vertical Plane.—In Fig. 3 assume a ring cut by two horizontal planes, A-A and B-B, so that arc A-B = $R d\theta$, where θ = angle radius of curvature makes with the horizontal and R = radius of curvature in inches. This ring is acted upon by three sets of external forces, T_1 and T_2, the tensions per inch of circumference at A and B, and the pressure of the water acting normal to the surface. The resultant of the two sets of forces, T_1 and T_2, acts inward and tends to cause compression in the ring. The water pressure p acts outward and tends to cause tension. The resultant of the horizontal components of these forces determines the net compression or tension on the ring.

Hoop Compression.—As $d\theta$ approaches zero, T_1 approaches T_2 and the angle between the resultant of T_1 and T_2 and R also approaches zero. Then resultant of T_1 and $T_2 = 2\,T_1 \sin \frac{1}{2}\, d\theta$. This can be written $T_1 d\theta$ because the smallness of the angle makes $\frac{1}{2}\, d\theta = \sin \frac{1}{2}\, d\theta$.

Resolve the above resultant into its horizontal and tangential components of which the horizontal component = $T_1 \sec\theta d\theta$ = $W \sec^2\theta d\theta/2\pi r$ [see equation (4)]. These components acting around the circumference will cause a hoop compression of

$$\frac{W \sec^2\theta d\theta r}{2\,\pi r} = \frac{W \sec^2\theta d\theta}{2\,\pi}$$

This compression acts over an arc $R d\theta$. Hence T_1 and T_2 cause a compression of

$$W \sec^2\theta/2\,\pi R \text{ per linear inch.} \qquad (5)$$

Hoop Tension from Water pressure.—The water pressure, p, is also divided into horizontal and tangential components, of which the horizontal component = $pR \sec\theta d\theta$. These components acting around the circumference will cause a hoop tension of $rpR \sec\theta d\theta$. This tension acts over an arc $R d\theta$. Hence the water pressure causes a tension of

$$pr \sec\theta \text{ lb. per linear inch.} \qquad (6)$$

Resultant Stress.—The resultant ring stress in a joint cut by a vertical plane is the difference between equations (5) and (6) and equals

$$pr \sec\theta - (W \sec^2\theta/2\,\pi R) \text{ lb. per linear inch.} \qquad (7)$$

When the above expression is positive the stress is tension; when it is negative the stress is a compression. The above formula applies to any suspended curved tank bottom. When the bottom is partially supported by the tank riser, the compression is less than indicated by the above formula.

OTHER TYPES OF BOTTOM

FOR a spherical or segmental bottom, if the water below the point considered is neglected, the first term of equation (7) $= prR/r = pR$ and the second term $= p\pi r^2R^2/2\,\pi R r^2 = pR/2$, so that the resultant tension in a joint cut by a vertical plane is

$$pR/2 = 1.3\, HD \text{ lb. per linear inch} \qquad (8)$$

where H = head in feet and D = diameter in feet of sphere.

To allow for the weight of the water below the section considered there should be subtracted from H a distance about equal to half the distance from the section considered to the lowest point of the tank bottom.

Prof. A. N. Talbot in the "Technograph" for 1902 gives the following formula for the stress in a joint of an ellipsoidal bottom cut by a vertical plane:

$$p[r' - (r'^2/2\, r'')] \qquad (9)$$

where r'' = radius of curvature in a vertical plane [same as R in equation (7)] and r' = radius in a normal plane at right angles to the vertical plane [same as $r \sec\theta$ in equation (7)]. Substituting these values in equation (9), it takes the following shape $pr \sec\theta - (pr^2 \sec^2\theta/2\, R)$ or $pr \sec\theta - (W \sec^2\theta/2\,\pi R)$, which is the same expression as equation (7).

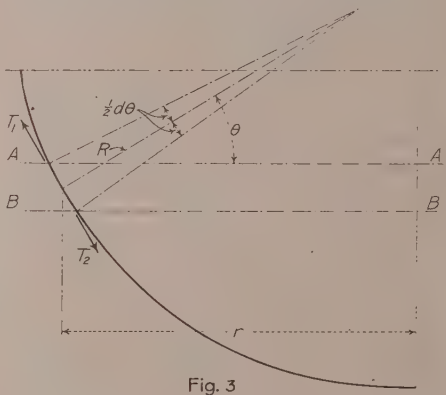


Fig. 3

For conical bottom R equals infinity and the second term of equation (7) drops out, leaving

$$pr \sec\theta \qquad (10)$$

In this case θ will equal one-half the angle at the vertex of the cone.

TRUE INTERNAL STRESSES

THE formulæ just derived give the apparent stresses and do not take into account lateral deformation. Taking into account Poisson's ratio, which is about 0.3 for steel, the actual stresses in tank bottoms will be considerably less than the apparent stresses, unless one of the latter is compression.

If a small section of a tank bottom (Fig. 4) be acted upon by an apparent unit tensile stress T_1 on the faces AD and BC, this stress tends to increase the length of the side AB and shorten the side AD. The unit stress T_2 tends to lengthen BC and shorten AB, so the actual stresses are less than T_1 and T_2. Using Poisson's ratio the actual stress along $BC = T_1 - 0.3\, T_2$ and the actual stress along $AB = T_2 - 0.3\, T_1$. If either stress is compression it is to be taken as negative in the formula.

For a hemispherical bottom T_1 and T_2

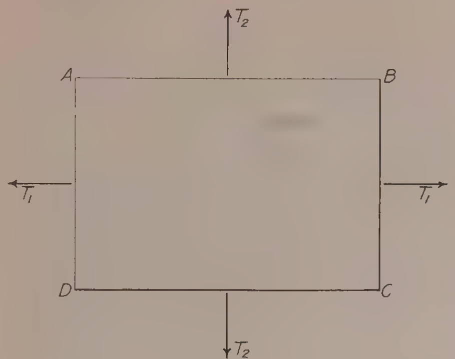


Fig. 4

are both tension and are approximately equal. Hence actual stress =

$$pR/2 - 0.3\,pR/2 = 0.35\,pR = 0.91\,HD$$

STRESSES IN 100,000-GAL. TANK

As an example, the apparent stresses in a 100,000-gal. hemispherical bottom tank are shown in Fig. 5. At $\theta = 45$ deg. the stress in a vertical joint $= 1.3\,HD = 1.3 \times 35.78 \times 22 = 1020$ lb. The stress in a horizontal joint $= W \sec \theta/2\,\pi r$, where $W = 444{,}000$ lb., $\sec \theta = 1.41$ and $r = 93.5$ in. Therefore, the stress $= 444{,}000 \times 1.41/2\,\pi\,93.5 = 1070$ lb.

The same result will be obtained if we take for the stress in a horizontal joint $1.3 \times H^1 \times D$, where H^1 equals H plus one-half the distance from the section considered to the lowest point of the tank bottom.

If the bottom is made of 5/16-in plates with lap joints and one row of ¾-in rivets spaced 2¼ in., the net section will be 0.147 in. and the unit stress (in a horizontal joint at $\theta = 45$ deg.) will be 7300 lb. per square inch.

Should the tank be built without a balcony and with sides and bottom of the same thickness, the dotted line to the right in Fig. 5 indicates about what the stress would be in a joint cut by a vertical plane. When the tank is built with a balcony or horizontal girder at the point of junction of the sides and bottom, this member will prevent deflection and the stress will be about as indicated by the dotted line to the left.

It is also true that each horizontal joint reduces the deflection at that point and lessens the stress for some distance each side of the joint. If Poisson's ratio is considered, the real stresses in the bottom will be found to be about 30 per cent less than the apparent stresses, while the stresses in the sides of the tank will remain unchanged.

A flat bottom has the disadvantages that corrosion occurs where the bottom plates rest on the flanges of the supporting beams. Also, due to the weight of the I-beam deck, the tank with a flat bottom weighs more and costs more than one with a self-supporting bottom. In the case of a conical or segmental bottom there is a large horizontal force at the connection of the tank sides and bottom. It is difficult to detail this connection properly and to make the joint watertight when erected. Nearly every elevated tank that has failed has had a conical or segmental bottom with an improperly designed connection to the tank sides.

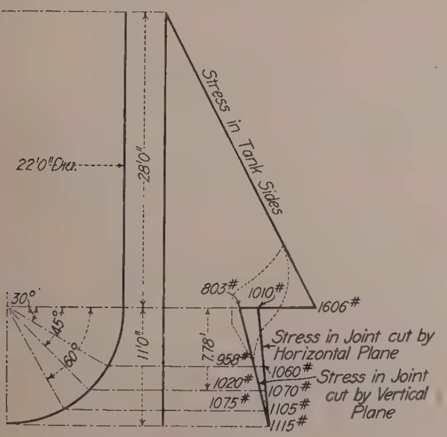


Fig. 5

In a hemispherical bottom the stresses are relatively low, all surfaces are open for inspection and painting, and the stresses in the bottom have no horizontal component at the junction of the tank sides and bottom.

The elliptical bottom has the same advantages as the hemispherical bottom. It has also the further recommendation that the depth, and consequently the variation in pressure, is less for the same diameter of tank. One manufacturer makes use of the fact that the bottom is practically flat at its lowest point by riveting a large steel riser pipe directly to the tank bottom. This practice does away with the necessity for an expansion joint and the riser pipe will carry part of the water load, the exact amount depending upon its diameter.

Comparisons of Systems of Flood Control

First of a Series of Papers Discussing the Advantages, Costs and Feasibility of Levees, Cutoff Channels and Reservoirs

By H. A. PETTERSON
Civil and Hydraulic Engineer, San Francisco

There are three general methods proposed for lessening flood damage: (1) Preventing floods by so regulating the runoff that overflow from the river channels cannot occur; (2) protecting the more valuable regions by high embankments and confining the flood waters to definite channels, and (3) removing all things perishable out of the area subject to flood. The third method is obviously practicable and advisable only to a very limited extent.

Methods for preventing floods strike at the cause. Excessive precipitation cannot be prevented, but excessive runoff can. Prevention aims to so regulate the runoff that at no time shall it occur in sufficient volume to overflow stream banks and inundate the adjacent valleys. Storage reservoirs and forests are illustrations of this method.

Protection strikes at effects rather than causes. It says: "This is too stupendous a monster to control, but defenses can be made strong enough to keep him out of our cities and farms. Instead of letting him wander at random, we will try to conduct him along thoroughfares where he will not do much damage." Levees, rectification of river channels, dredging and outlets are illustrations of this method.

Four general systems for controlling floods have been most extensively advocated in the prolific literature on the subject. Two of these systems—levees and outlets—come under the general method of protection. The other two systems—forestation and storage reservoirs—come under the general method of prevention.

It is the purpose of this paper to point out the salient features of each of these four systems and to compare the systems generally, their advantages, drawbacks and limitations.

A rather thorough study of flood literature has convinced the writer that there has been too much of a partisan spirit and too little of a real scientific spirit displayed by advocates of particular systems of flood control. Much good, however, has come from the heated arguments of the past. It is generally becoming understood that each river is a law unto itself and that no one system of flood control will prove best for all rivers. A study of any river system, for the purpose of devising the most feasible means of preventing floods, or inundation therefrom, will be incomplete unless the possibilities of all the systems are taken into consideration. A combination of two or more systems may often prove the most feasible and productive of the greatest benefits.

LEVEES

The method adopted for regulating the lower Mississippi consists in the construction of earth embankments or levees on both banks of the river, dredging the bars formed during high water, and revetting the river banks to prevent caving. Because of association with the lower Missippi, the levee system, as generally understood, includes, as adjuncts, dredging and bank protection. Bank protection is admitted to be necessary by the engineers in charge of the lower Mississippi, and estimates of its costs have been made. Comparatively small amounts of revetment have been constructed, however, because of the failure of Congress to appropriate funds therefor. The estimated cost of levee construction that usually appears in print omits this very large and important item of bank protection. Hence the first cost of levee construction seems small. One of the greatest advantages of the levee system in our complicated organization of society is the fact that it may be constructed piecemeal or in detached units. A city desiring protection against overflow does not have to unite with other cities or reclamation districts. It can act alone and build a high dike completely encircling its territory and feel safe from inundation as long as the embankments remain intact. Other advantages are the ease and simplicity of construction and the directness of the method. This directness appeals to the average man. He can see the relation between cause and effect. The cause of his losses is the overflow of his land. The effect of levees (when they do not break) is to keep this overflow out. The average man would not appreciate the effect of reservoirs located hundreds and perhaps thousands of miles away from his land.

The history of levees in civilized countries as a whole teaches that no levee system is absolutely safe from breaks. Additions to the levee and renewals and repairs seem to be required annually. The charges for maintenance and renewal are very heavy and the levee is a continual source of expense for upkeep. Damages from crevasses increase rapidly as the height of levees in-

Panoramic View of Site for New Plant of Massachusetts Institute of Technology;

creases. A point is finally reached, as on the Po in Italy and the Yellow River in China, where the damage from break, including the cost of maintenance and repair, more than balances the benefits gained from the flood protection. (See paper on "Floods and Means of Their Prevention" by Col. T. P. Roberts in "Proceedings" of the Engineers' Society of Western Pennsylvania, July, 1907.)

Levees also complicate the drainage of lands previously subject to overflow and make pumping necessary.

Outlets of Auxiliary Channels

OUTLETS find many advocates among engineers, particulary for the lower Mississippi. It does not seem to be generally known that an engineering commission was appointed by the President of the United States in 1874 to investigate and report a permanent plan for the reclamation of the alluvial basin of the Mississippi River subject to inundation. (Report in Ex. Doc. 127, H. R., Forty-third Congress, Second Session; also pages 539 to 565, Report of Secretary of War, 1865, Vol. 2, Part 1.) This commission considered cutoffs, diversion of tributaries, reservoirs, outlets, and levees. All plans except levees were rejected. Outlets were discussed at considerable length. The conclusions of the board are as follows:

"In fine, then, this commission is forced, unwillingly, to the conclusion that no assistance in reclaiming the alluvial region from overflow can judiciously be anticipated from artificial outlets. They are correct in theory, but no advantageous sites for their construction exist."

It has often been stated that this commission thoroughly investigated the feasibility of reservoir construction for reducing flood heights on the lower Mississippi. Its report bears no evidence of any exhaustive investigation or of any investigation whatever except for a lake near Shreveport. Reservoirs were rejected because this commission believed no adequate site for reservoirs existed.

This commission did, however, place itself on record as most decidedly opposed to the closing of the Atchafalaya. The report states:

"We now reach the Atchafalaya River, a large natural outlet carrying to the Gulf 120,000 sec.-ft. in time of flood. This outlet it has been proposed to close, and we desire to place on record our decided disapproval of any such scheme. On the contrary, the rafts and obstructions in its bed near its point of entrance into the lakes should be removed and its capacity to discharge its waters without overflowing its banks in that vicinity be thus improved."

The commission also advises the reopening of Bayous Plaquemine and La Fouche, if careful surveys find their tendency to dangerous enlargement is not well founded.

The outlet system was recommended for the Sacramento Valley, and portions of the general project are under construction. (Report of California Débris Commission, submitted June 29, 1911.) It is spoken of in California as the Government by-pass. The channels composing the by-pass are formed by parallel lines of levees in the lower parts of the flood basin. These channels vary in width from about 1700 to 12,000 ft. and in capacity from 35,000 to 500,000 sec.-ft. The estimated cost, exclusive of lands, is $33,000,000.

Forestation

SOMEONE has aptly stated that advocates of forestation, while having all of the arguments, have none of the records. Runoff and rainfall records, covering long periods of time, show that forests do not prevent disastrous floods. Appendix V of the final report of the Inland Waterways Commission contains the result of a most thorough investigation of the subject, with a bibliography containing twenty-nine pages. The articles enumerated in this bibliography probably number from 800 to 1000. The conclusions of the commission are as follows:

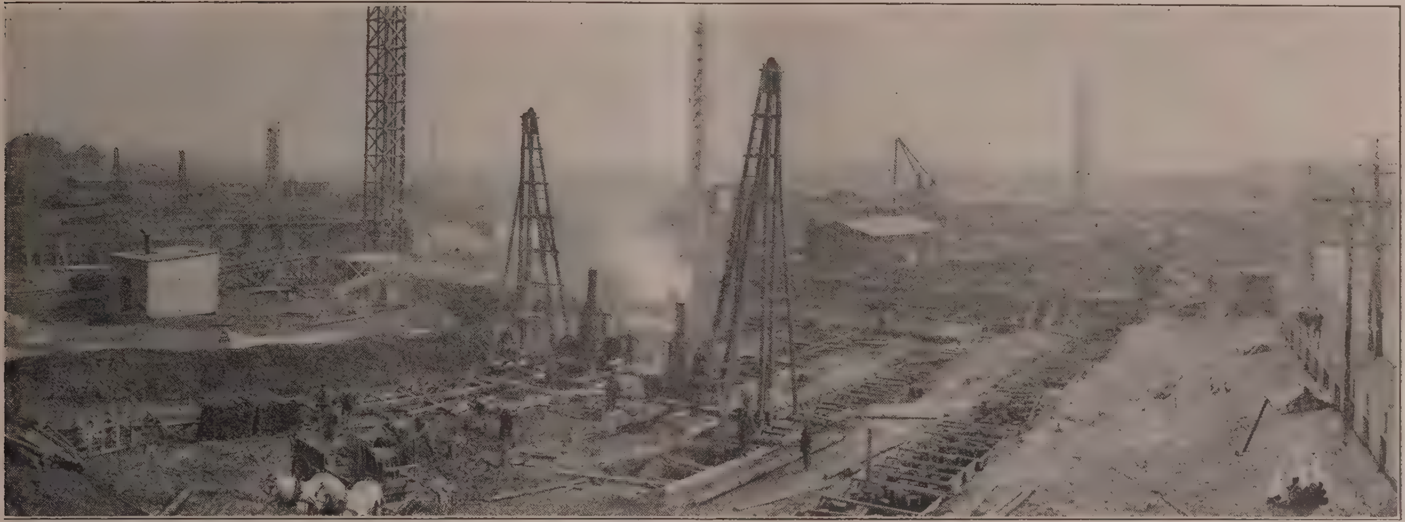
"Whatever influence forests may have upon precipitation, runoff and erosion, it is evidently greatest in the mountainous regions, where the rainfall is heaviest, slopes steepest, and runoff most rapid. Here, also, the land is less useful for other purposes. The extent of the influence of forests upon these three factors varies greatly, according to circumstances involved in each case. Under one set of conditions forests may benefit stream flow and mitigate floods, while under other conditions they may have the opposite effect. In no case can they be relied upon to prevent either floods or low-water conditions. There is substantial agreement on that point. Nor is their influence extensive enough to warrant their use as the only means of securing the uniformity of stream flow, which is desirable for navigation or the development of water power. For this purpose storage reservoirs would be much more effective."

Reservoirs

THERE is substantial agreement among all engineers that storage reservoirs are the ideal method of preventing floods, as they get at the cause. The principal reasons for their rejection in the past were their high first cost and the supposed lack of suitable natural basins. There is still a division of opinion on the question of the practicability of the reservoir method when considered from a combined legal and financial point of view. It is also objected that reservoirs built to prevent floods cannot be used for other purposes. The benefits to be gained from the impounding and regulating of runoff are many. Thus there are benefits to navigation by increasing the low-water flow, to water supply for cities and towns, for irrigation and power development. The Pittsburgh Flood Commission estimates that an expenditure of $6,000,000 is warranted by the annual saving possible in soap consumption in that city alone.

The reservoir system is particularly valuable in those sections of the country where all the surface water supply is needed for irrigation. It seems an economic blunder to employ other methods for flood control in such regions, doubly so when the watersheds producing the greater part of the runoff are in the mountains where high heads for power development can be secured. Reservoirs add immeasurably to the national wealth because they conserve one of the greatest sources of wealth.

Reservoirs may be divided into natural and artificial. Natural reservoirs of stupendous volume exist in the numerous ponds, lakes and stream beds on the earth's surface. Other natural reservoirs of great capacity are to be found beneath the earth's surface, in the rocks and gravels composing the earth's crust. The porosities in the alluvial gravel deposits form subterranean reservoirs of immense capacity. The possibility of the artificial replenishment of these ground water supplies was probably first suggested by Prof. E. W. Hilgard. In Southern California the idea has passed the experimental stage as a method of flood-water conservation. The method employed in spreading the flood water over the coarse gravel of the alluvial slope is described in the 1912 report of the Conservation Commission of California.



Entire Construction Laid Out in Eight Divisions, Each Independently Operated

Construction Layout for New Technology Plant, Cambridge

Buildings Have Been Divided for Erection into Eight Groups, Each Independently Equipped and Operated

HEREWITH is presented a panoramic view of the site on which the new buildings for the Massachusetts Institute of Technology are under construction. The lot is about 1500 ft. square and the buildings in the background are at a distance somewhat greater than that. The grounds are bounded by Massachusetts Avenue, leading to the Harvard Bridge, and by the Charles River Esplanade and Basin. The main office of the Stone & Webster Engineering Corporation, from the roof of which the view is taken, is about two-thirds the length of the lot from the river, its entrance being on Massachusetts Avenue, which is at the right-hand end of the picture.

For convenience and celerity in construction the buildings have been divided into eight groups. Each unit will be independently equipped with houses and apparatus, will have its own group of workmen, and will build as if it were the only structure on the grounds. There will be eight towers for concrete, each with its trestle, bins for sand and stone, storehouse for cement and car and incline to the mixer. The mixers will be at the foot of the towers, and by the layout every point will be covered by the reach of the conveyors. Five standard-gage railway tracks have been built running the length of the grounds, so that supplies may be delivered with a single handling.

DETAILS OF LAYOUT

IN the picture there are six towers already in place. There will be a seventh placed at the trestle and bins to the left of the center in the foreground, while the eighth unit will be to the left beyond the white building, where the boiler plant of 4000 hp will be placed. The footings for the buildings of the department of mechanical engineering are to the right, with two pile drivers at work setting piles, 25,000 of which will be needed for the entire educational group, which is the one under way.

The foundations of the mechanical engineering section have presented some problems of arrangement, for the instructing force in charge of hydraulics has called for a suction well which is 20 ft. square by 30 ft. deep, together with canals for measuring the flow of streams. These are already in place near where the pile drivers are working.

The general arrangement of trestle and bins is shown by the group to the left center of the picture. The trestles, which measure altogether about 700 ft. in length, are standard in construction. The mixture is made with the minimum of manual labor. It drops by gravity to the car, which, drawn up the incline, deposits its contents in the mixer.

The long building near the boom derrick is the carpenter shop, and here there is an equipment of saws and other machines for making forms that will call for twenty men. The lumber in stock at present is 1,500,000 ft., while more than 500,000 ft. have already been used. The storage for the reinforcing steel is at the extreme left of the picture, where, on an incline, the steel is delivered largely by gravity into proper bins.

It is unnecessary to name every structure in sight, for there is here a village whose day population when the frost is gone will be at once more than two thousand men. The air of activity is evident, the enormous amount of supplies, of which the piles and lumber are most noteworthy in the view, together with the vast extent of the estate—fifty acres in all, on twelve of which operations are under way—speak of an undertaking of such magnitude that its "motion picture" as it develops from month to month will be a most interesting study.

Reverting Specification for Paving Bitumens

Progressive Restrictions in Awarding Contracts Advocated by Testing Engineer

CONDEMNATION of the loose phrasing of many of the prevailing specifications for bituminous paving materials was voiced by H. P. Pullar, engineering chemist, of Detroit, in an address delivered at the annual meeting of the Michigan Engineering Society, held at East Lansing Jan. 13-15.

Most of the specifications which are in use at the present time are so open, he said, that the producing companies may practically ignore their requirements. Little attention need be given to keeping the material uniform and of the highest grade.

In order to overcome this trouble and make specifications of greater value Mr. Pullar suggests the drawing of a broad specification, so open that it will admit all desirable bituminous materials. At the time of awarding the contract the successful contractor will state what bituminous material he will use, and will agree to use an asphalt complying with a specification for that particular class, or even brand, of material. The contractor and the producer of the material would then have to supply a bituminous material complying with a strict specification and one which could take under consideration the local conditions. In order to explain this more fully, conditions in a middle western city, where specifications are so open that the penetration limits for the asphalt cement are 40 and 90, are cited. Were it not for the desire of the producers to supply suitable material for the work it would be possible for them to supply under this specification a Bermudez asphalt having a penetration of 85, or a California asphalt having a penetration of 40, the use of either of which would result in serious trouble. Under the suggested reverting specification it would be possible to let the contract under a broad specification in which the limits for a bituminous material were from 40 to 90; but as soon as the contract was let the specification would revert to the particular brand or class of material, compelling the contractor to supply Bermudez asphalt of the proper penetration or a California asphalt of the proper penetration. For instance, in the lower part of Michigan a penetration of 50 to 60 for Bermudez asphalt and a penetration of 60 to 75 for California asphalt—for sheet asphalt pavements—would be specified.

Most failures of bituminous pavements can be traced to improper or careless use of the various materials entering into their construction. In order to get the best results on bituminous work it is necessary first to specify desirable materials. Before the materials are used they should be tested to see that they comply with specifications and that they are of uniform quality, and then, as a further result of the tests, the proper way to use them should be determined. If this is done, better results will be obtained and bituminous material will find greater favor with engineers as a class.

Lime Putty and Cream of Lime

Discussion of Laboratory Tests Made to Determine Volumes of These Substances a Given Quantity of Lime Would Produce

INABILITY to locate definite and reliable data as to the volumes of putty and cream of lime which a given quantity of lime will produce, for use in specifying cement-lime mortar mixtures for stucco and other purposes, was the incentive for a series of laboratory tests conducted in the laboratory of Westinghouse, Church, Kerr & Company. The specific purpose of the tests was to determine certain constants of lime putty and cream of lime, such as weight per unit volume, weight of lime in a unit volume, and volume resulting from slaking and wetting a given weight of quick lime. The tests were discussed by Cloyd M. Chapman, engineer of tests for the company, in a paper presented at the recent convention of the American Concrete Institute.

PROCEDURE

IN carrying out these tests the following procedure was followed: Eight dealers in lime in New York City were requested to forward to the laboratory 5-lb. samples of their lump lime. These samples as received were placed in airtight metal cans to prevent absorption of moisture and air slaking. A representative lump was chosen from each sample and its specific gravity determined by the displacement method, using water-free kerosene oil as the liquid.

Another sample of each lime tested was broken and slaked with water in a wide-mouthed bottle to which a reflux condenser was attached, so that water evaporated by the heat of slaking would be returned to the bottle. After cooling, additional water was added to make a paste or putty of a certain consistency, which was adopted as a standard for these tests. This consistency was such that with the Chapman consistency apparatus (see Engineering Record of July 12, 1913, page 52) a drop of 3 in. would produce a spread of the liner of about 0.25 in. using a cylinder 1⅞ in. in diameter and 3 in. high. This consistency is one suitable for use in regular work on the job. The flask was then carefully filled with water from a burette up to the 300-cu. cm. mark in order to determine the volume of the putty. This water was run down the side of the flask so as not to mix with the putty. When the flask had been filled the water was carefully decanted, leaving the lime putty in the flask.

CONSISTENCY

THE consistency may be very definitely determined as follows: The paste is thinned gradually by the addition of small amounts of water at a time, taking care to stir sufficiently after each addition of water to produce a uniform consistency and break up all lumps. The proper standard consistency is determined by dipping a wood paddle ½ in. wide by about ⅛ in. thick into the cream and spooning up what cream can be lifted. The paddle is now tipped up into a vertical position, and if the cream on the paddle flows sluggishly off the end without the assistance of any jarring then the consistency is that sought. If the cream adheres and does not flow then it is too thick; if it flows freely, it is too thin. By this method one particular consistency may be determined with considerable accuracy.

From the observations recorded and the computations made the accompanying table was prepared. Each determination was made several times with each lime, and the figures given are in each case averages. The analyses presented were furnished in most cases by the manufacturer, but where this information was lacking the sample was analyzed in the laboratory. In the table the first eight samples are "high-calcium" limes, as they contain 95 per cent. or more of CaO, while the other two were low-calcium or magnesian limes.

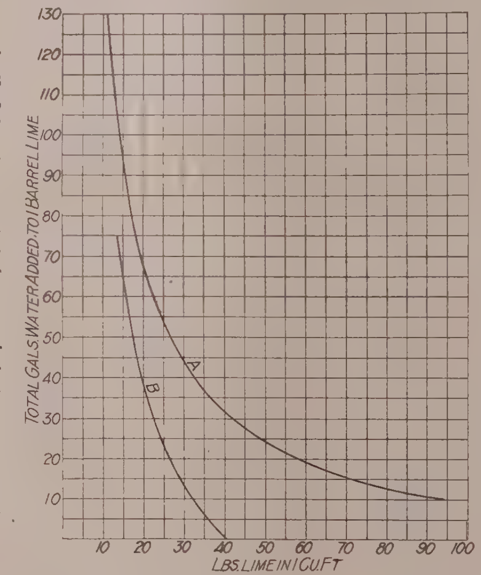


Fig. 1—Relation of Water to Lime

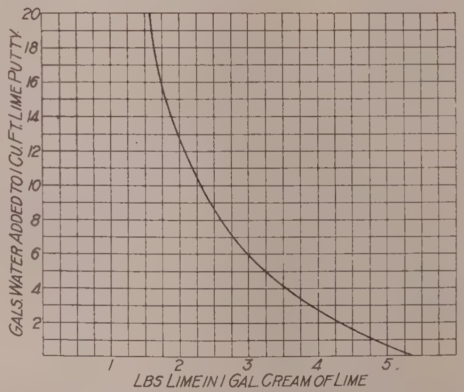


Fig. 2—Curve Derived for Convenient Use

GRAPHICAL RESULTS

IN order to show graphically the relation between the amount of water used in making a putty of standard consistency from quick lime and the weight of lime in a cubic foot of the resulting mixture, the results given in the table were plotted as shown in Fig. 1 by curve A. In this curve the gallons of water required to make putty of one barrel of lime are plotted as ordinates against the pounds of lime in one cubic foot of the putty as abscissae, and in the same manner the gallons of water required to make cream of lime of one barrel against the pounds of lime in one cubic foot of the cream.

The points all fall close to the curve, which conforms to the formula

$$y = \frac{200}{(x/7.5) + 0.8}$$

in which y = water in gallons added to the barrel of lime; x, lime in pounds in 1 cu. ft. of the resulting mixture, there being 200 lb. and approximately 0.8 cu. ft. of lime in 1 bbl., and 7.5 gal. of water in 1 cu. ft.

It is apparent, therefore, from the close agreement between the points determined experimentally and the mathematically plotted curve that it is quite unnecessary to perform any experimental work in the laboratory to determine the amount of lime in a given volume of a lime putty of any consistency, provided the amount of water that has beeen mixed with a given weight of lime is known. By the use of the curve or the formula the weight of lime in a cubic foot of any mixture of lime and water may readily be determined.

The difficulty lies in knowing, or being able to determine, the amount of water that is actually added to the lump lime. This difficulty is brought about by the evaporation of a considerable portion of the water that is added to a lump lime during the slaking process. Even if the water added to a barrel of lump lime is carefully measured there is no easy method of determining on the job how much water is left after slaking is complete. A series of trials made in the laboratory with all materials at room temperature of about 70 deg. Fahr. showed an average evaporation of about 20 per cent of the water. This would probably vary a great deal, depending upon con-

TABULATED RESULTS OF LIME TESTS

	High-Calcium Content									Low-Calcium Content		
Source	York, Pa.	Farnum, Mass.	Farnum, Mass.	Rock-land, N. Y.	West Stock-bridge, Mass.	York, Pa.	Adams, Mass.	West Stock-bridge, Mass.		Dover Plains, N. Y.	Knicker-bocker, Pa.	
Marked	Chemical lump lime	Lump lime	Lump lime	Lump lime	Lump lime	Lump lime	Granular lime	Lump lime	Average	Dutchess County lime	Lump lime	Average
Analysis, CaO	99.04	98.91	98.91	96.81	95.23	95.00	94.87	84.31	95.38	56.46	56.99	56.72
Analysis MgO	0.65	....	....	1.27	0.71	....	0.84	5.84	1.16	38.54	40.11	39.32
Analysis SiO_2	0.10	0.73	0.73	0.42	3.46	....	2.05	3.54	1.38	1.58	2.11	1.85
Analysis R_2O_3	0.12	0.36	0.36	0.88	0.60	0.36	1.86	2.00	0.77	1.60	0.79	1.14
Specific gravity	1.665	1.696	1.575	1.614	1.535	1.638	....	1.742	1.638	1.600	1.516	1.558
Water, per barrel, to make putty, gallons	29.4	32.2	32.7	30.5	32.4	29.1	32.9	28.3	30.9	25.3	22.8	24.0
Lime in 1 cu. ft. putty, pounds	43.1	38.7	38.0	44.6	41.2	41.8	38.6	45.2	41.4	50.6	56.5	53.5
Weight of 1 cu. ft. putty, pounds	95.2	93.0	89.3	100.1	96.7	92.2	91.5	97.8	94.4	102.4	109.0	105.7
Water, per barrel, to make cream, gallons	68.1	75.7	105.8	73.5	96.0	76.4	109.2	73.2	84.7	72.6	37.4	55.0
Lime in 1 cu. ft. cream, pounds	21.0	20.4	13.3	20.0	15.7	19.4	12.9	19.0	17.7	21.5	34.6	28.0
Lime in 1 gal. cream, pounds	2.8	2.84	1.76	3.76	2.08	2.56	2.28	2.52	2.56	2.84	4.4	3.6
Weight of 1 cu. ft. cream, pounds	78.7	78.9	70.5	78.8	74.3	76.0	71.0	75.9	75.5	77.8	87.8	82.8

ditions of temperature and amount of water used. This curve is therefore of small practical value to the man on the job.

CURVE B

CURVE B shows the relation between the weight of lime in a cubic foot of mixture when the amount of water which is added to putty to reduce it to cream is known. This curve is based on the assumption that the average amount of water has been used to make the putty. On this assumption the formula becomes

$$y = \frac{200}{(x/7.5)+4.92}$$

in which the constant 4.92 represents the volume in cubic feet of putty produced by 1 bbl. of lime.

By means of this curve, if it is known how many gallons of water are added to the putty produced by one barrel of lime to reduce it to cream, it can be determined how many pounds of lime are contained in each cubic foot of the cream, whatever its consistency. Inasmuch as the amount of lime in a cubic foot of putty is a reasonably constant quantity, and as it is usual for lime to reach the stage of putty at some time during the process of preparation, it seems that this offers the best basis on which to build up a specification for mixing mortars. If a high-calcium lime is to be measured when in the putty state, having a consistency of rather soft butter, it may with reasonable accuracy be assumed to contain 41.5 lb. of CaO per cubic foot; but if the lime is to be measured in the liquid state, having a consistency of good rich cream, in which condition it is most easily mixed with sand and cement to a uniform mortar, then some means must be provided to determine the amount of lime in a given volume. The variation between different limes in the amount of water they require to make a cream of a given consistency is so great that no general figures can be safely applied.

To put the data in the most usable and convenient form a third curve is given in Fig. 2, which shows the relation between the amount of water added to 1 cu. ft. of putty of standard consistency to reduce it to cream and the weight of lime in 1 gal. of the resulting cream, regardless of its consistency.

It may be well, Mr. Chapman concludes, to add a caution against accepting these figures for general use until they have been either verified or modified by tests made on a much greater number of samples obtained from many parts of the country.

"Third Degree" for River Gage

SWEPT from its mooring by the recent flood, a Friez automatic river gage which had spent eleven years registering the stages of Kings River, in central California, for the U. S. Geological Survey, was washed ashore at Sanger. This is what the Fresno "Herald" has to say about it: "An intricate infernal machine which, if loaded with nitroglycerine and discharged, could have done inestimable damage, was found in the flotsam deposited near this city by the recent flood. The machine consists of a clocklike arrangement attached to a brass cylinder. It is inclosed in a glass case. This instrument of destruction is now in the hands of Constable Campbell and will be turned over to Government officials."

Kinks in Concrete-Road Construction

Notes for the Contractor Relative to Formwork, Mixing, Placing and Protection Against Too Early Opening to Traffic

POINTS of value to the concrete-road contractor brought out in a paper presented by C. D. Franks at the recent meeting of the Indiana Engineering Society are that forms for 800 lin. ft. of road will be required to handle the work properly on a 16-ft. road; that from 300 to 500 ft. of 16-ft. pavement can be laid in a day and the work will be delayed if 800 ft. of forms are not available; that the form setters should keep far enough ahead of the mixer so that the subgrade can be checked, and that for a large job it will be economical to protect the top of the forms with a metal strip.

A careful checking of the elevation of the foundation at frequent intervals of, say, 2 or 3 ft. by the use of a straightedge or string, resting on or stretched from the top of the side forms, and a rule is important in order to insure the proper thickness of the finished concrete. This may seem like an unnecessary requirement, but variation of less than 2 in. cannot, or will not, be detected by the eye. Failure to check the foundation as outlined will result in decreasing the thickness of the pavement at the center 25 per cent or more where full strength is absolutely essential.

MIXING

THE actual mixing of the concrete is of the utmost importance. Frequently, in practice, the time the materials remain in the drum is governed only by the speed of the gang charging the skip. At times the batch mixer is operated practically as a continuous mixer by fastening the discharge scoop or spout so that there is a constant flow of concrete from the mixer. Such a practice is a source of constant controversy between the inspector or engineer and the contractor. In all cases the drum should be completely emptied before the next skip of material is dumped into the mixer.

Other things being equal, the quality of the concrete is materially improved by thorough mixing. To insure this the speed in revolutions per minute of the mixer and the time the batch remains in the mixer after the water is added should be specified. To specify the one without the other is not sufficient, as is shown by the fact that on fifteen jobs the speed of the mixer varied from 7 to 32 r.p.m. and the time of mixing varied from ten seconds to two minutes, irrespective of the revolutions per minute (see Engineering Record of Feb. 21, page 215). The drum speed should be about 16 r.p.m. for a minimum and about 21 for a maximum. The materials should remain in the drum at least three-fourths of a minute, and one minute would be better. Tests have shown that where concrete is mixed less than this time its strength is materially less than where the concrete is mixed three-quarters of a minute or more.

The strike board should always be worked forward about perpendicular to the axis of the roadway, and as it is moved ahead should be sawed back and forth across the road. At least two passages, and sometimes more, of the strike board over the surface will be required to produce a finish of the desired character.

When a concrete road has been laid in the late fall it is frequently difficult to determine when it will be safe to throw the road open to traffic. In some cases it may be necessary to open the road before the engineer in charge feels that it would be absolutely safe to do so. Under such conditions if about 3 in. of straw are placed on the pavement and this covered with several inches of earth the surface of the pavement may be protected sufficiently to allow the opening of the road a week or two sooner than could be safely done without such protection.

Conductivity of Creosote

Notes on Results of Laboratory Tests to Determine Effect of Creosoting of Ties on Track Circuits

LABORATORY tests to determine the conductivity of creosote and creosote-treated ties and thus the practical bearing on track circuits of the creosoting ties, are described and discussed in the recent report of the committee on signals and interlocking of the American Railway Engineering Association. The discussion is abstracted as follows:

The results would indicate that dry creosoted ties in themselves do not possess very high conductance; nor is their conductance increased to any great extent by the addition of a slight percentage of moisture. The amount of water poured on the sample in one of the tests may be assumed as equivalent to a shower on ties in well-drained track. It was impracticable to reproduce conditions experienced in some locations, where the ties may be submerged for hours or days.

The addition of salt solution brought forth such a great reduction in resistance as to brand this substance as a great detriment to successful track-circuit maintenance. While it is assumed that 2 lb. of salt per tie represents an extreme case, yet the accumulation of brine from refrigerator cars, year after year, may mean that the residue remaining in the tie will eventually approach the amount used in this test.

The cross-grained measurement tends to prove that the resistance is less with the grain than along the year rings or radial lines.

There are approximately 3200 cross-ties per mile of single track. If all of these possessed the same resistance as the creosote mixture used in treating, and there was leakage of current between rails through no other path, the resultant leakage resistance per mile of track would be 58.7 ohms, or 310 ohms per 1000 ft. From the data obtained the following leakage resistances are calculated, it being assumed that all leakage is due to ties alone: Dry, 4.07 ohms per mile, 21.5 ohms per 1000 ft.; wet, 3.44 ohms per mile, 18.2 ohms per 1000 ft.; salt solution, 0.336 ohms per mile, 1.77 ohms per 1000 ft.

STANDARD FOUNDATION loads adopted by the bridge department of the National Transcontinental Railway, Canada, allow 4 to 6 tons per square foot for clay in thick beds, always dry; on clay, moderately dry, 2 to 4 tons; on gravel and coarse sand, well cemented, 8 to 10 tons; on compact, well-cemented sand, 4 to 6 tons; on clean dry sand, 2 to 4 tons. Average pile loads of from 15 to 20 tons each are permitted. Piles are driven to an average penetration of 1 in. in the last few blows of a 2000-lb. hammer falling 25 ft. This gives a calculated safe bearing load of 25 tons.

Davenport Riverfront Improvement

Description, with Cost Data, of Work Designed to Withstand Ice and Floods and Protect Land Being Reclaimed with Buried Garbage

By WILLIAM H. KIMBALL
M. Am. Soc. C. E., Consulting Engineer

RECLAMATION of land and waterfront protection are being carried out at Davenport, Iowa, according to a scheme that is in some respects different from the work being done elsewhere on the Mississippi River. It was necessary to provide against the scouring action of ice and also to protect the area being reclaimed by dumping garbage and burying it with material from excavations. On one occasion during a flood period a mattress of wire mesh filled with hay was used successfully to hold the garbage uncovered by the water. Cost data of some of the work are given.

Davenport has a population of about 45,000, and opposite are the cities of Rock Island and Moline, Ill. With their suburbs the three cities have a combined population of about 100,000. The entire frontage on the river within the city limits of Davenport is about 4 miles. The harbor line as established and now existing extends over about 2 miles of this frontage. The map shows the situation on the Davenport side. By the action of the War Department in establishing this line the city recovered a tract of more or less submerged land between the river bank and the line varying in width from 100 to more than 600 ft., and aggregating about 170 acres in area.

RIVER STAGES AND ICE

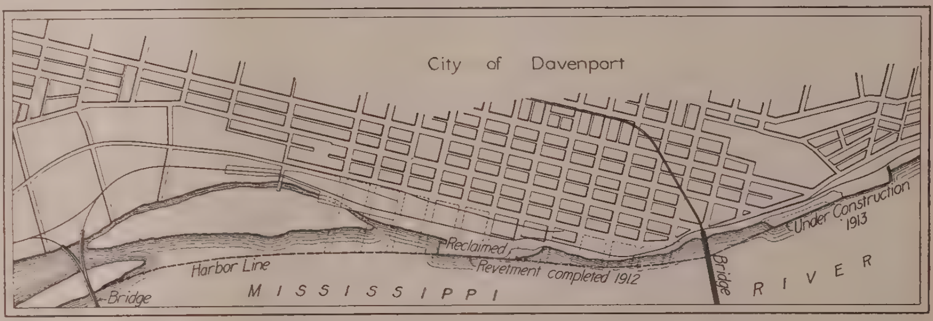
VARIATION in the river stages at Davenport is considerable and is responsible for the high cost of any form of wall or revetment for shore protection. This variation between high and low-water marks is 18.6 ft., with one record of 19.2 ft. During any year a variation of 13 ft. may be expected.

Usually for some period in the winter months the river is frozen over, and during severe winters ice 20 in. thick forms in the running water. Near the shore it may be much heavier, due to one layer piling on another. When the ice goes out in the spring this movement is usually preceded by warm melting weather, during which the river stage rises, thus lifting the ice free of the shores and finally floating it out. Although it is usually quite rotten when it moves, if a heavy and rapid rise occurs it may be so solid that considerable damage results.

Records show that the ice has moved out on stages of from 3 to 11 ft. Occasionally "jams" form and "shoves" of the ice occur which have been heavy enough to top the banks 18 ft. above low water and overturn freight cars standing near. During a period of twenty-five years the following heights have been reached: More than 19 ft., once; more than 18 ft., three times; more than 15 ft., four times.

ELEVATION OF WALL

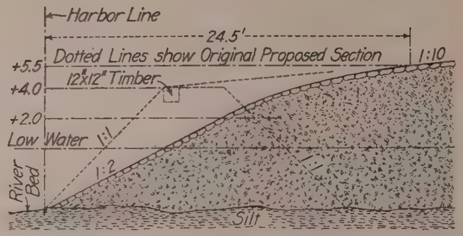
THE commission appointed by the city to study the situation, to which the writer is consulting engineer, concluded that at present it was not justified in placing the top of the revetment wall above +15 of the gage, although it is intended that a short distance back of the wall the fill will be sloped up to El. +20, and that any industrial establishments will be located with the lowest floor at El. 21 or 22. Should experience show that it is advisable to raise the top of the revetment, the commission considered that this additional height could be added to the existing wall. It is evident from these facts that a wall or revetment presenting a nearly vertical face may be subjected to rather severe conditions.



Plan of City of Davenport, Indicating Adopted Harbor Line

In addition to the actual pressures against the wall there must be considered the action of the ice on the stone fill. Freezing to the stones in the winter the outgoing ice in the spring carries with it a considerable amount of stone, disintegrating the base and rendering it more liable to damage by wave wash. The grinding and moving of the ice against the wall and base still further loosen the stones.

While the rate of the current in the river near the shore is not high, the effect of this action, together with the wash of the waves, must be provided for. It has also been found that boats and barges occasionally drift against or strike the wall, a contingency that must be anticipated.



Proposed Section of Steamboat Levee

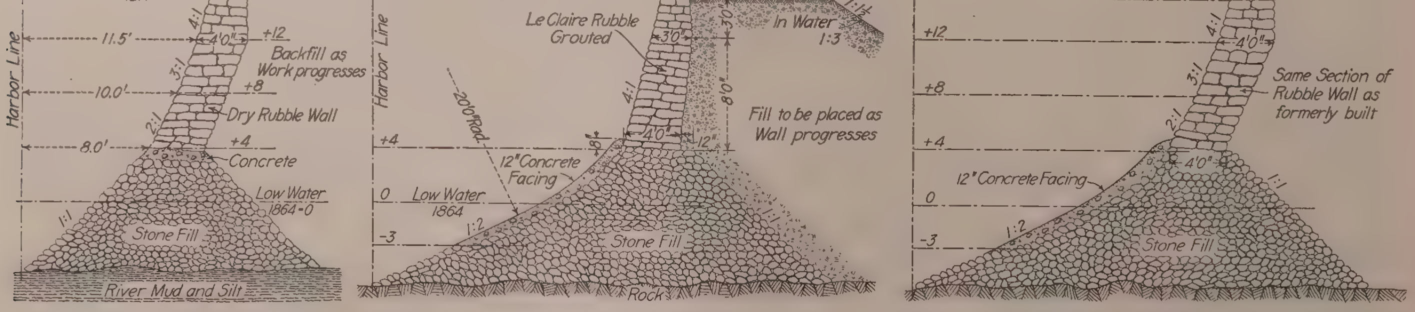
GARBAGE DISPOSAL

UNTIL 1910 the city had followed the custom usual along the river of loading its garbage on dump boats during the open-water season and periodically taking them out into the stream and dumping them. During the winter months the garbage was often deposited on the ice to be carried out with it in the spring. During the last few years of this antiquated disposal method some sorting of the garbage and refuse was attempted.

In May, 1911, the War Department notified the city to cease dumping garbage into the river. John W. Alvord, consulting engineer, was then engaged to investigate and report upon a plan for garbage disposal, and he recommended what may be called the burial method of disposal.

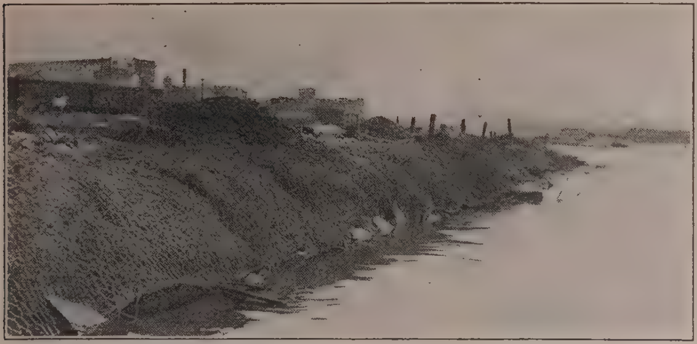
By this method of disposal it was estimated that 4 cu. yd. of covering material were required for each 3 cu. yd. of garbage. The commission was, therefore, confronted with the necessity of immediately providing some form of revetment or protection for the garbage fill, as well as for the large quantity of refuse material of all kinds then in place and constantly accumulating.

That portion of the riverfront where dumping was in progress was adjacent to the business district. Along this portion of the work the harbor line was about 300 ft. from the existing bank, the depth of

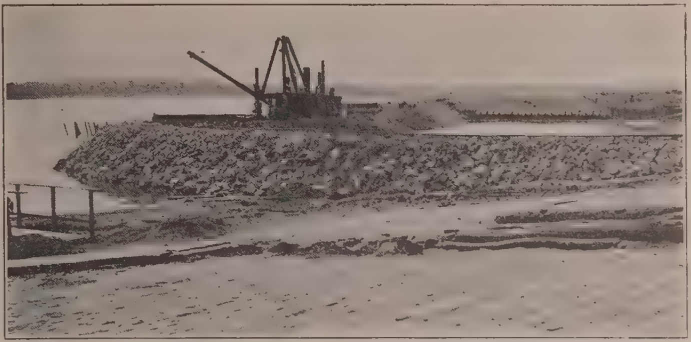


Section Built 1911 and 1912 Section Suggested 1913 Section Adopted 1913

Design of River Wall at Davenport as Built, Showing Modification Made After Submission of Suggested Section in 1913



Wire Mesh and Hay Mattresses Protecting Fill



Rockfill for Base before Silting or Consolidation

the water below low water was from 4 to 7 ft. and the bottom consisted of several feet of silt overlying a firm material. Some attempt at protection had resulted in a light stone fill along or near the harbor line, and it was decided to continue the work by a random stone fill topped by a dry rubble revetment wall.

WALL DESIGN

THE design finally adopted by the commission for this work in 1911 is shown in the drawing and the photograph herewith. The original section of this work was first proposed by the writer, who was then a member of the commission. The design as finally built was the result of some modifications by the various members of the commission.

About 1200 ft. of this section were constructed in 1911 and 1912, and the work has passed through two winters—one of heavy ice—and through a flood reaching within 2 ft. of its top. Though certain features of its design are open to criticism, it has proved satisfactory to the commission.

The original design for the wall contemplated the use of crushed stone back of the revetment to prevent wave wash. The use of sand for filling back of the wall, however, seemed to justify filling the joints roughly with concrete, no attempt being made to grout the joints, but simply to prevent injurious wave action and yet leave the wall joints open enough for drainage. The concrete cap on the stone-fill base has been discontinued.

In all revetment work a supporting fill of sand has been provided as the work progressed, the area back of this dike, so formed, being filled by the dumping of garbage with its covering and excavated material from foundations and streets. The practice is followed of permitting the random stone fill to silt up and consolidate for one season before placing the rubble wall upon it.

WIRE MESH MATTRESSES

IN 1911 the river began to rise and finally reached a height where the water uncovered a part of the garbage fill, creating for a few days a decided nuisance. It was necessary to protect the face of the fill by some method and at the suggestion of the writer mattresses of wire mesh filled with hay were used. These mattresses are shown in the illustrations. Weighted with stone and wired at the top, they formed an effective protection.

Another contingency developed when hundreds of rats, attracted by the garbage, took up residence in the brush and rubbish which composed part of the fill. A combination of fire and poison finally reduced their number, but this circumstance calls attention to the necessity of keeping all harboring places for such pests cleaned up.

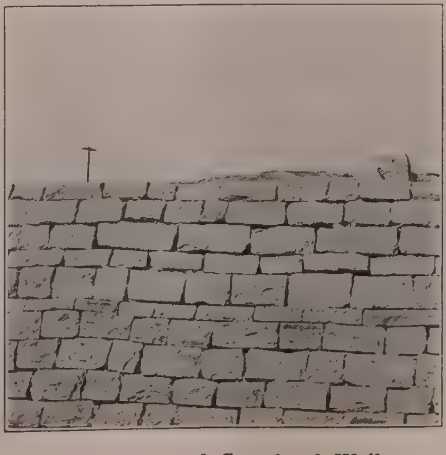
Davenport is naturally well drained, practically its entire area being tributary to the river. The older sewers, while really combined sewers, carried in most cases but little storm water owing to lack of capacity, and the sewers found their way to the river by the most direct route. The result of this was to provide nearly every street within the business district, and many in the rest of the city, with sewers running directly to the river. The city is not prepared for extensive reconstruction of its sewer system, and within the frontage now being improved by the commission some storm sewers have been built and the sewers carrying house sewage have been extended to the harbor line.

In the future the discharge of municipal wastes into streams like the Mississippi will no doubt have to be done, in a manner not only sanitary, but inoffensive to the eye.

METHOD OF CONSTRUCTION

NONE of the work of actual filling and revetment has been done by contract except the purchasing of material. The commission has so far carried on the work by day labor, under its own superintendent and foremen. No great investment in plant has been justified, and the materials have been handled either direct from barges or from cars to small dump cars running on narrow-gage tracks to the work. Last season the sand for filling was furnished unloaded and placed within reach of the 75-ft. dredge boom. The work begun in 1911 under the plans outlined was almost completed in 1912, as far as the actual revetment was concerned.

Owing to the difficulty of separating the costs of various portions of the work, accurate figures are not available, but approximate costs were about as follows:



Appearance of Completed Wall

Riprap stone fill, averaging 3.5 cu. yd. per linear foot, per foot	$7.95
Rubble stone revetment, 1.6 cu. yd. per linear foot, per foot	6.90
Sand for filling unloaded back of wall, per cubic yard	.38

The cost per linear foot is about as follows:

Random stone fill	$7.95
Rubble stone revetment	6.90
Minimum-section sand backfilling	3.00
Coping and railing	2.75
Total	$20.60

The stone used in the random fill is a limestone of good quality and plentiful in the locality. In can be bought on barges or cars at the work for about $1.10 per cubic yard, and holds 2300 lb. to the cubic yard. The rubble stone used for the revetment is known locally as "LeClaire stone" and comes from a quarry near the town of LeClaire, Iowa, about 16 miles above Davenport on the river. The cost of rubble stone, f.o.b. Davenport, is about $1.70 per cubic yard of 2300 lb.

In October, 1912, the writer was retained as consulting engineer for the commission. The field work was then in charge of John Malloy, who remained in this position between the above date and May, 1913. Various studies and designs were developed, which resulted in submission to the commission of the sections shown in the drawings.

STATUS OF WORK

UNTIL June, 1913, the river remained at too high a stage for much work to be done, but since that time considerable random stone fill has been made and some rubble wall built.

No cost data are available as yet for the season's work except the following:

LeClaire rubble stone, per cubic yard of 2300 lb. f.o.b. work	$1.67
Riprap stone for cubic yard of 2300 lb., f.o.b. work	1.03
Sand fill deposited by dredge from barge at limit of 75-ft. boom, per cubic yard	.35

In considering the work done by the commission it must be borne in mind that the land thus far reclaimed lies opposite the business district and that its value is high. The commission estimates that the cost of the reclamation is amply justified by the return which it anticipates from such portions of the land as will be leased for commercial purposes. Whether the present plan of construction is continued in the future will depend, no doubt, upon the results secured.

Jetting Wooden Sheet Piles

WOODEN 6 x 12-in. sheet piles 28 ft. long were driven through 10 ft. of water to a penetration of 13 ft. and a depth of 6 ft. below the subsequent excavation to make cofferdams for two piers of a double-track bridge of the Camden & Burlington branch of the Pennsylvania Railroad across the Rancocas River at Hainesport, N. J. The bottoms of the piles were sharpened on both sides and were beveled on one edge to draw together in driving. A 2500-lb. drophammer was set on the pile top and water at 120-lb. pressure was forced through two 1¼-in. steel pipes 30 ft. long, flattened at the lower end to form a ¼ x 1¾-in. nozzle. The resulting fan-shape jets with a pressure of about 80 lb. were considered more efficient in scouring across the faces of the piles than circular jets would have been. One jet operated on each side of the pile, aided by occasional blows from the hammer, caused the piles to penetrate through 3 ft. of mud and silt and about 10 ft. of fine sand at the rate of twelve or fifteen piles per nine-hour day. Except for some roots and soft pieces of wood, which were generally cut through by using the hydraulic nozzles as chisels, few obstructions were encountered. The engagement of the piles was good, and they formed a tight cofferdam through which there was little leakage. The work was executed by the Stillman-Delehanty-Ferris Company, of Jersey City.

OF 6000 LEAD SERVICES in Lexington, Ky., only one gave any trouble last year, according to W. S. Cramer, superintendent of waterworks, in a discussion at the recent meeting of the Indiana Sanitary and Water Supply Association. The pipe, which gave away during a fire under 125-lb. pressure, served a church organ and swelled to the size of a baseball before breaking.

Repair of Twin Peaks Reservoir

How Excessive Leakage Due to Defective Joints in a 10,000,000-Gal. Reinforced-Concrete Bowl Was Eliminated

TWIN PEAKS reservoir is the main storage source of supply for San Francisco's high-pressure fire-protection system, described in the Engineering Record of July 26, 1913, page 108. The reservoir, as the illustrations show, is a reinforced-concrete bowl divided in half by a narrow concrete wall buttressed and heavily reinforced. Each compartment has a capacity of 5,000,000 gal. To provide for temperature changes and possible earthquake shock 10,476 lin. ft. of expansion joints were provided. Different types of joints were used in various locations in the reservoir lining, as shown in the drawings. When first filled the leakage from a single compartment amounted to more than 2,000,000 gal. per day. This was due principally to a radical defect in the design of such unsupported joints. A contributory cause was imperfect adhesion in places between the asphaltum filling and the walls of the concrete slabs, as well as defective shaping of the taper joints by the contractor.

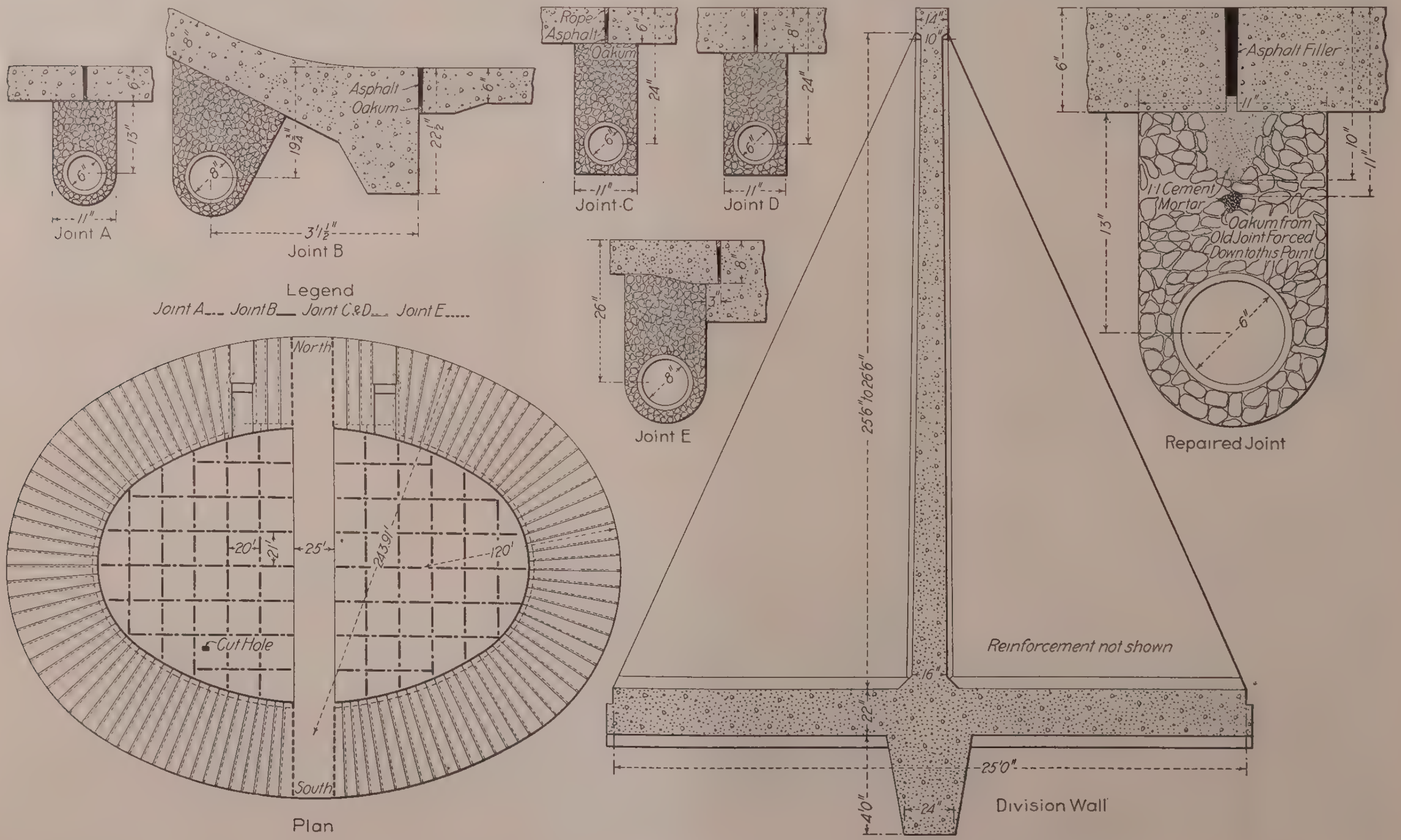
WEST COMPARTMENT REPAIRS

IN repairing the joints the first task, after emptying the reservoir, was to remove the defective asphalt filler. Most of this was done with a plowshare mounted on four wheels and moved along the joint with a windlass operated by four men. It was impracticable to use this device along the circular seam B, on the side seams within 3 ft. of the foot of the slope or on the joint along the bottom of the division wall. From these joints the asphalt was removed by hand with long chisels and 10-lb. sledges. The oakum originally placed in the joint was next driven 5 in. below the bottom of the concrete and left embedded in the broken rock which surrounds the underdrain. Next the joints were thoroughly scraped and cleaned with hand chisels, and just below the joint a cavity for its entire length was gouged in the broken rock beneath. After reshaping with mortar any portions of the joint chipped or broken by the above-described operations a grout of 1 part cement to 2 parts sand was poured through the seam into the broken rock below, until after tamping it stood 1½ in. above the bottom of the slab.

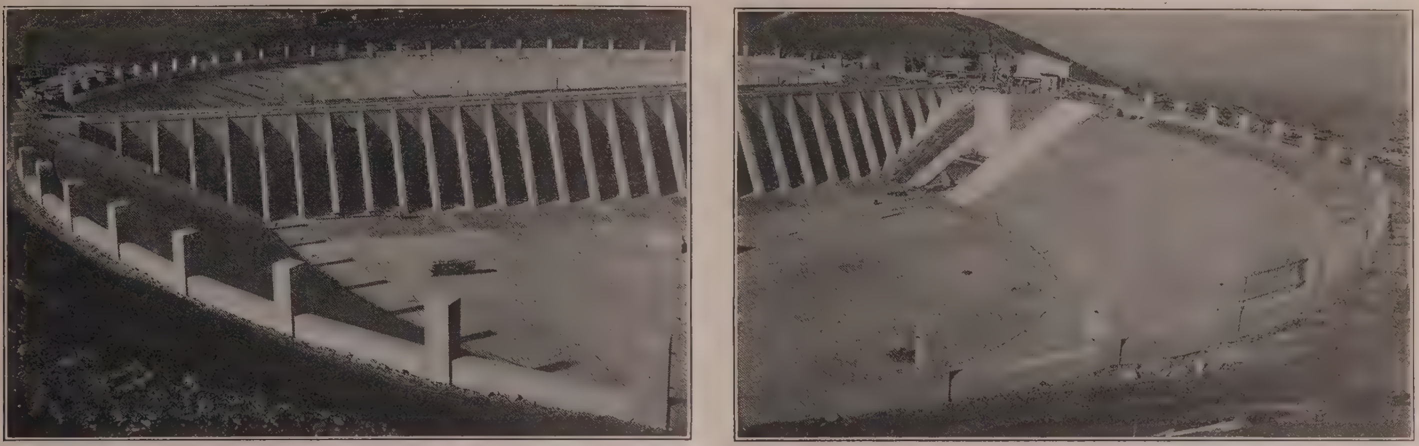
Next the sides and bottom of the joints were coated with paint and when this had dried were filled with a mixture composed of asphalt and infusorial earth. For joints in the bottom a mixture of 95-per cent D-grade asphalt and 5-per cent infusorial earth was poured at a temperature between 300 and 400 deg. Fahr. Into the slope seams a mixture was placed consisting of 82½-per cent asphalt and 17½-per cent infusorial earth at a temperature ranging from 375 to 400 deg. Fahr. The bottom joints were then scraped down 1 in. and filled to overflowing with soft D-grade asphalt, which was spread for 4 in. on either side of the seam. On top of this a 6-in. strip of felt was ironed down over the seam and mopped with asphalt.

EAST COMPARTMENT REPAIRS

THE above-cited repairs were made on the west compartment. For the east compartment the process was similar, except that the bottom joints were covered with 8-in. instead of 6-in. strips of felt, and the whole reservoir lining was coated with coal tar, which when dry was mopped



Plan of Twin Peaks Reservoir, Section of Division Wall and Details of Asphalt-Filled Joints



Interior of Twin Peaks Reservoir at San Francisco, Showing Lining and Buttressed Division Wall

with a thin coat of D-grade asphalt mixed with 5-per cent infusorial earth. English coal tar was chosen after various brands of paint and asphalts, as well as ordinary coal tar and mixtures of these, had been tried experimentally. To secure proper adhesion between coal tar and concrete it was necessary that the former be applied just at the boiling point. This necessitated heating a small amount at one time (about 2 gal. when four men were pouring), for when larger quantities were heated at once the exact temperature could not be maintained, the tendency being toward overheating.

At the present time there is practically no leakage in the reservoir. The repair work was performed under the direction of M. M. O'Shaughnessy, city engineer.

Mastic Lining for Acid Tanks

New Preparation That Has Withstood Laboratory Tests and Has Been Ordered for a Copper-Mining Plant in Chile

CONCRETE tanks are used in connection with the copper-mining operations of the Chile Exploration Company in Chuquicamata, Chile, and as a protection against the action of sulphuric acid a new method of lining them has been developed.

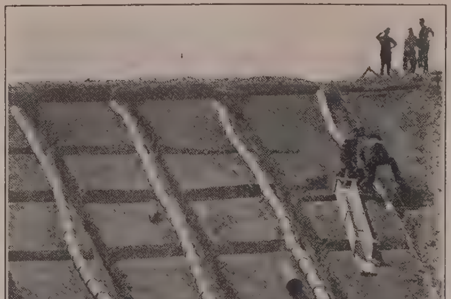
The company's copper ores in Chile are handled by the combined sulphuric-acid and electrolytic method. After the ore is crushed it is put into large tanks or vats and then leached with a 10-per cent sulphuric-acid solution for twenty-four hours. The solution containing the copper is led through another process for extracting chloride and then passes to the electrolytic tanks. There the copper is extracted and the remaining solution, which is now increased in sulphuric acid, owing to the copper being separated from its chemical connection with sulphur, is returned to the leaching vats ready for extracting the copper from a new batch of ore.

It can readily be seen that the large tanks required must be such as will withstand sulphuric acid, which, of course, concrete would not do unless provided with a protective lining. Experiments with tanks of various types were made, but in most instances proved failures. It was then suggested that a specially prepared acid-proof asphalt mastic lining might be used to overcome the difficulties encountered. In co-operation with E. A. Cappelen Smith, consulting metallurgical engineer of the Chile Exploration Company, experimental tanks—among them one 15 ft. high—lined with Trinidad asphalt mastic were installed at the research laboratory of the American Smelting & Refining Company, of Maurer, N. J. With these tanks there was duplicated as nearly as possible the operation of extracting copper as it is carried out in Chuquicamata.

Under the direction of Mr. Smith various other materials were also experimented with at Maurer, but they all proved unsuitable, with the exception of the asphalt mastic. As this material has shown no defects or deterioration after a year's test, the Chile Exploration Company has placed the contract for lining with asphalt mastic about 150 concrete tanks or vats from 15 to 16 ft. in depth and from 120 to 150 ft. in exterior dimensions.

The lining of these tanks in Chile will require from 1250 to 2000 tons of asphalt mastic, which is being prepared in the United States and shipped to Chile. The first cargo of 500 tons was shipped in February, and as soon as it arrrives an experienced superintendent and nine mastic workers will be sent to Chile to do the lining of the tanks.

The experimental work at Maurer, the preparation of the asphalt mastic and its application to the concrete tanks were carried out by Henry Wiederhold, manager of the Vulcanite Paving Company, of Philadelphia.



Drains on Slopes of Twin Peaks Reservoir

(The trenches for these pipes were filled with rock, as indicated in joints C and D in the details shown on page 398. Placing unsupported expansion joints over the trenches caused leakage.)

Electricity Prevents Water-Supply Pipes from Freezing

ELECTRICITY was used last winter to prevent water from freezing in supply pipes used in connection with the construction of the hydroelectric development of the Cedar Rapids Manufacturing Power Company near the city of Cedars, Quebec. The design of this development was described in the Engineering Record of Oct. 25, 1913, page 461. Near the site is located the 10,000-hp hydroelectric plant of the Provincial Light & Power Company, from which power is taken for construction purposes. Water is pumped by two centrifugal pumps from the St. Lawrence River into a 6-in. main 1½ miles long buried in the ground along the headrace, which is now in course of construction. At intervals 2-in. branches buried for most of their length are taken off. To the end of these branches the 1-in. supply pipes for the steam shovels are connected. These pipes are above ground, as continuous shifting prevented them from being buried.

How much electricity was needed to keep these 1-in. pipes from freezing was not scientifically determined, but it was found that when the temperature was below zero and even as low as —27 deg. Fahr. 40 kw at 220 volts would keep a 1500-ft. pipe from freezing even if water was standing in it. A 1000-ft. pipe needed 20 kw at 110 volts and a 2-in. pipe 100 ft. long required 14 volts.

The current is delivered on the job at 2200 volts, and by banks of transformers is stepped down to 220 and 110 volts. The connections between the pipes and these transformers consist of copper wires wound around both ends of the pipes. The wires are so attached that the current follows the flow of water in the pipe. To prevent the water from freezing back of the point where the wire is attached this connection is buried in the ground.

On the pipes supplying compressed air to the various drills and hoisting engines it was noticed that when the temperature dropped below 5 deg. Fahr. no trouble was experienced from the moisture in the air. For temperatures from 5 to 40 deg. there was difficulty when the air was not reheated. That no reheating was necessary for the lower temperatures is explained by the theory that the air was so cold that the moisture was frozen out of it before entering the machine. The work is carried out under contract by Frazer, Brace & Company, of New York City.

Tunnel Construction and Ventilation for Railroads

Conclusions Outlining What the American Railway Engineering Association Deems the Best Practice under Various Conditions

AFTER a general consideration for several years of the subject of tunnel construction and ventilation, the committee on roadway of the American Railway Engineering Association has reached conclusions, which have been adopted, as follows:

1. Railway tunnels, as ordinarily constructed in the United States, are more economically built by first driving the heading entirely through, but such method usually requires a greater length of time for completion of the tunnel.
2. For material requiring support the top heading should usually be driven.
3. It is economical and expedient to use an electric shovel or an air shovel for the removal of the bench where the section of the tunnel permits its safe operation; and where the material does not require support there are advantages in low cost and quick removal of the bench in driving the heading at the subgrade line.
4. Where the time limit is of value, the heading and bench should be excavated at the same time, the heading being kept about 50 ft. in advance of the bench. Where the material of roof is not self-supporting and timbering is to be resorted to, the bench should not be removed until the wall plates are laid and the arch rib or centering safely put up.
5. Opposing grades should preferably not meet between the tunnel portals so as to put a summit in the tunnel. Where practicable, the alignment and ascending grades in the tunnel should be in the same direction as the prevailing winds.
6. The accompanying drawings are representative of American practice in single-track tunnel construction, where the time limit is of value.

EXPLANATION OF FIGURES

THE typical method in hard rock with few seams is shown in Fig. 1. The heading in material of this kind is usually driven by a V cut, using from sixteen to twenty-two holes about 8 ft. deep. The holes near the middle of the heading are drilled so as nearly to meet at the end. These holes are shot first, then the second row and lastly the outside holes. The arrangement of these holes will vary slightly, according to the way the material breaks.

The bench in material of this kind is usually taken out in two lifts of almost equal weight. The sub-bench is drilled from 20 to 40 ft. in advance of the bench. From four to eight holes in a row, with 6 or 8-ft. face, are used in both sub-bench and bench. One or two rows of holes may be used. The center holes are shot first and the side holes last.

For moderately hard rock with seams the method outlined in Fig. 2 is employed. The heading is usually driven by a "hammer" cut, using from fourteen to twenty holes 6 to 10 ft. deep. The bottom row of holes is inclined at an angle of about 30 deg. The rows are shot in succession, beginning at the bottom. The holes should be arranged to suit the seams in the material.

The bench is sometimes taken out in one lift, but usually in two, with the sub-bench not as deep as the bench. The sub-bench is best drilled from 20 to 40 ft. in advance of the bench. From four to six holes in a row may be used with from 6 to 10-ft. face. The center holes are shot first and the side holes later.

The method indicated in Fig. 3 is used only when the material is so soft that the heading cannot be driven for the full length of timber used for the wall plates. Drifts about 4 ft. wide and 6 ft. high are driven for each wall plate, and the core is taken out as the timber rings are put in. Three or four holes from 3 to 5 ft. deep may be used in each drift. The amount of shooting necessary depends entirely upon the softness of the material, which can often be picked. The core may be soft enough to pick, or may be shot with from four to eight holes, drilled either from the face as shown or from the sides of the drifts.

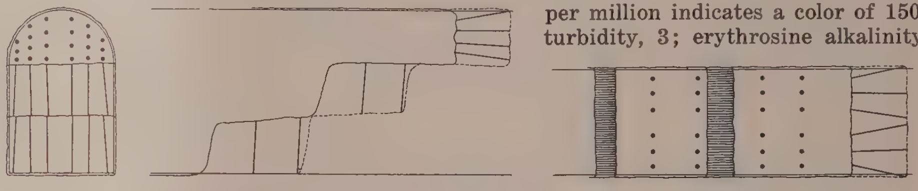


Fig. 1—V Cut for Use in Hard Rock with Few Seams

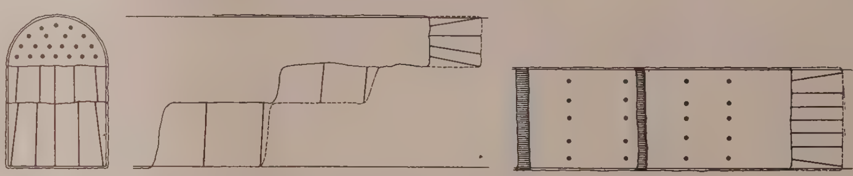


Fig. 2—Hammer Cut for Fairly Hard Rock with Seams

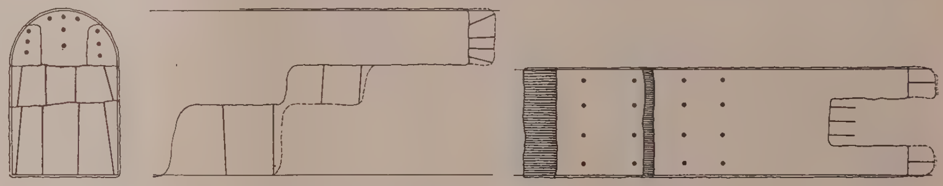


Fig. 3—Method Applicable to Soft Rock or Hard Clay

In this class of material the bench is shot in one or two lifts. Only a few holes are necessary.

TUNNEL VENTILATION

MOST practicable, effective and economical artificial ventilation for tunnels carrying steam-power traffic is to be obtained by blowing a current of air into one end of the tunnel for the purpose of removing, or of diluting and removing the smoke and combustion gases at the opposite end. As practised in America, this way of procuring ventilation partakes of two methods:

1. To blow a current of air in the direction the train is moving and with sufficient velocity to remove the smoke and combustion gases ahead of the engine.
2. To blow a current of air against the direction of the train with velocity and volume sufficient to dilute the smoke and combustion gases to such an extent as not to be uncomfortable to the operating crews and to clear the tunnel entirely within the minimum time limit for following trains.

ABOUT 135,000,000 RAILROAD TIES are used each year in the United States.

Remodeled Rapid-Filter Underdrains at Charleston, S. C.

INCRUSTATIONS filling the strainer openings in the under-drain system of the 6,000,000-gal. daily rapid-filter plant of the Charleston Light & Water Company at Saxon, S. C., led the officials to replace the laterals in the strainer system by perforated pipes. Calcium compounds filled the strainer openings completely, a heavy deposit being found in the inside and outside. The remodeling of the underdrains was described in a paper by Jesse M. Worthen, M. D., superintendent of the Charleston Light & Water Company, presented March 11 to the Illinois Water Supply Association.

Water from this plant is taken from a 3,000,000,000-gal., 2500-acre unstripped reservoir, part of which was formerly salt marsh. Average analysis in parts per million indicates a color of 150; turbidity, 3; erythrosine alkalinity, 10; phenolphthaleine alkalinity 0; hardness, 22.1; carbon dioxide, 7.3. Treatment of the water consists of 2 grains per gallon of Natrona aluminum sulphate added to the water leaving the low-lift pumps on the way to two 5,000,000-gal. settling basins, which give a combined period of forty hours' sedimentation. As a recoagulant 0.25 grain is added as the water passes through a 24-in. pipe from basin 1 to basin 2. To increase the alkalinity in the filtered water 0.75 grain per gallon of hydrated lime is added to the water in the flume connecting the filters to a 2,000,000-gal. clear-water basin. Relief beyond thirty days from incrustation, beginning April, 1912, was not secured by cleaning the strainers by hand or by immersing in a nitric-acid bath, and finally, after consultation with the American Pipe Construction Company, new pipe laterals drilled with ¼-in. holes spaced on 6-in. centers were placed with the holes turned downward. A system of wood stringers was secured by copper spikes to the filter bottoms. Three layers of gravel, 6 in., ¾ to 1 in.; 4 in. of large pea size, 2 in. of small pea size, were filled over the pipe system. To hold the gravel down 100-mesh copper screening was fastened to the wooden stringers by copper nails passing through copper washers.

Book Reviews

The Conservation Law of the State of New York has been issued as a 275-page 4 x 5½-in. paper-bound pamphlet. It includes the amendments to the law made up to the close of the regular session of 1913. (Albany, N. Y., Conservation Commission.)

Recent publications of the National Board of Fire Underwriters include a list of gas, oil and chemical appliances complying with the Underwriters' requirements, a list of fire appliances meeting the same standards, rules and requirements for the construction and installation of dip tanks and for the construction and installation of gas shut-off valves. (New York, National Board of Fire Underwriters.)

Final report on the removal of the wreck of the battleship "Maine" from the harbor of Havana, Cuba, being a document transmitted by the Secretary of War to the House of Representatives, has been printed as Document 480 of the Sixty-third Congress, second session. It makes a book of thirty-six pages, accompanied by sixty-nine illustrations, most of which are line drawings of considerable size. The report explains in detail the progress of the operations, the conditions encountered, and the final cleaning up. Costs of the work, which aggregated $785,774 net, are given. The cofferdam, it will be remembered, was a very interesting structure. Copies of the document can be secured from the Superintendent of Documents, Government Printing Office, Washington, D. C.

"Levee and Drainage Laws of Texas" is the subject of Bulletin 2 of the Reclamation Department of the State of Texas. The booklet, which contains 61 pages, is divided into three parts—the improvement (levee) district law of 1909, the drainage district law of 1911 and the State Reclamation Department law of 1913. Previous to the passing of these laws there was the law of 1907, to which an amendment was made in 1909. The drainage district law of 1911, however, is a re-enactment with much new matter. The drainage laws of 1905 and years previous are not referred to, as they authorize two or more counties to join in the establishment of a single district, a provision omitted in the law of 1911. The State Reclamation Department law of 1913 repeals the State Levee and Drainage Board law of 1911, which repealed the law of 1909 creating that board.

"The Mortar-Making Qualities of Illinois Sand" is the title of Bulletin 70 of the Engineering Experiment Station of the University of Illinois. The author is C. C. Wiley, of the department of civil engineering of the university. Although sand is one of the most common materials in engineering construction, it usually receives only little care in its selection and use. Specifications for sand are generally so brief and indefinite as to be of little value. This condition of affairs is probably due in a large measure to the lack of definite knowledge of the mortar-making qualities of typical sands and to a lack of appreciation of the fact that sands from different deposits differ greatly in their characteristics and that these characteristics exert a marked influence on the mortar or concrete made from the sands. The bulletin gives the results of a series of tests on thirty-two samples of Illinois sands obtained from various parts of the State and discusses the effect of the characteristics of the sand on the quality of the mortar. From these considerations a proposed classification of sands is offered, with specifications for each class. The cost of the booklet is 20 cents.

FLOODS AND LEVEES OF THE MISSISSIPPI RIVER. By Benjamin G. Humphreys, Member of Congress from Mississippi. Cloth, 7 x 10 in.; 350 pages. Memphis, Tenn., Mississippi River Levee Association.

Representative Humphreys has brought together in this book all of the historical data regarding the control of floods on the Mississippi River, with the object of placing in the hands of his colleagues in the Sixty-third Congress all of the information that will help to guide them in connection with the flood-relief measures to be presented in Congress this year. The book is a brief not only for the levee system but also for congressional appropriation for raising the levees to their full designed height. The chapters are as follows: Proposed legislation; endorsements of great men, past and present; history of the levee system; long fight for Federal aid; levees under the administration of the Mississippi River Commission; whether levees are in the interest of interstate commerce; the Mississippi River and the Panama Canal; the constitutional questions involved. In the appendixes are various addresses and extracts from hearings on the Mississippi River problem.

STEEL DESIGNING. By Edward Godfrey. Leather, 4 x 6½ in.; 480 pages; 200 illustrations. Pittsburgh, Edward Godfrey. $2.50.

(Reviewed by F. H. Constant, Professor of Structural Engineering, University of Minnesota.)

The first two books of this series, by the same author, entitled "Tables" and "Concrete," respectively, are well known to structural engineers. The present volume pertains to steel designing. It includes nearly 500 pages of close print illustrated with a great number of text and full page cuts. It is divided into 33 chapters covering every phase of steel designing, such as the working and preservation of iron and steel, notes on detail drawing, the designing of bridges, buildings, beams and girders, tension and compression members, rivets and riveted connections, end connections of tension and compression members, splices, pins, loads and unit stresses, estimating weights, shear, camber, curvature, provision for expansion and contraction, traction, drawbridges, tanks, greenhouses, gears, inspection, illustrations of actual design in various classes of structures, general data, specifications and definitions.

The author has had a wide experience in designing and inspecting structural work and the keynote of the book is sound and correct design. It is wholly descriptive and discusses at length each detail of design and construction. It emphasizes the importance of details, of simple and rational methods and the interrelation of designer, drafting office, shop and inspector. Many of the author's critical articles in the periodic press are well known and in this book he points out a great many common errors in structural design. Chapter 30 contains 150 drawings of details of actual structures throughout the structural field along with the author's brief running comments.

Owing to the wide amount of ground covered, more than a general review of the book cannot be attempted here. The author states that he has attempted to make it useful alike to student, instructor, draftsman, designing engineer, shop foreman and inspector. It should find a place in college work by supplementing the hand-books and the more theoretical treatises upon structural design and supplying much of that information based upon experience which the instructor now has to communicate by word of mouth.

The chapter on general engineering data contains notes and descriptions of special accomplishment in the structural field, mentioning the largest or heaviest bridges and buildings of every type, notable methods of erection and other unique features, both in this country and abroad, information often difficult to get at quickly.

The book closes with a general specification for structural steelwork which is conservative and in line with good current practice. In his unit stresses the author follows the Cooper scheme of adding nothing for impact and making the dead load working stress twice that for live load.

GOVERNMENT OWNERSHIP OF RAILWAYS. By Samuel O. Dunn, Editor of "Railway Age Gazette." Cloth, 5 x 7½ in.; 400 pages. New York, D. Appleton & Co. $1.50 net.; by mail, $1.62.

Government ownership is to-day one of the most interesting and important questions before the American public, for it involves not only the future of our public-service enterprises and our industries but also the welfare of the entire nation. Economic questions affecting the wages and well-being of the worker are inseparably bound up with the fundamental one of the extent of government control. Furthermore, government regulation always raises the question of government ownership. A comprehensive book, therefore, on government ownership of railways is most timely.

Mr. Dunn's presentation of the subject is thorough and no student of present economic conditions can afford not to read it. The subject is such a broad one that this review cannot point out the full merits of the work, but if it succeeds in impressing upon the reader that he should get and thoroughly digest the book, it will have accomplished its object.

The general plan of the work is to compare railway conditions here with those in other countries, both where railways are privately and publicly owned. At the close of the presentation of data as to each phase of the railway problem conclusions are drawn and in a final chapter these are reviewed and the answer, as the author sees it, stated.

The first three chapters discuss the relation of railways to the State and the causes of government ownership abroad. Then in successive chapters are taken up the cost of capital; organization and personnel; influence of various factors, including political and labor conditions, on economy of management; adequacy, quality and safety of service; rate-making; financial results; condition of labor, and political effects.

Throughout is evidence of Mr. Dunn's well-known attitude of facing railroad problems squarely and speaking his mind fearlessly, even though the railways may be hurt. In other words, if the reviewer has rightly read the work it is a fair presentation of the problem. In some particulars readers will not agree with his conclusions, but the facts are stated clearly, so that those who differ may have the figures before them upon which to base their opinions.

Mr. Dunn's conclusions as to government ownership in the United States seem to be best summarized in the following paragraph:

"Since doubtless it is owing to these differences in conditions that State railway management in Prussia and Japan is a success, while in most other countries it is much less successful, or a failure, it does not seem illogical to conclude that any other country, in order to attain as high a degree of success in the management of State railways as Prussia and Japan have, must follow the example that Prussia and Japan, and especially the former, have set in organizing and managing their railways. But the example set by Prussia in organizing and managing its railways probably could not be followed without following the example set by Prussia in many other ways; Prussia could not have organized and managed its railways as it has and does if it had not had the kind of government and people that it has. Now, for the people of countries such as the United States, England, France, Canada and Australia to follow the political example of Prussia would be for them to revert to a form of government and to political institutions which they regard as inconsistent with the rights of the individual to great freedom of action and with the right of the people as a whole to govern themselves."

And again he says: "Clearly the preponderance of the evidence does not indicate that, under existing conditions at least, the adoption of government ownership in the United States would be beneficial to the public."

FACTORY ORGANIZATION AND ADMINISTRATION. By Hugo Diemer, Professor of Industrial Engineering, Pennsylvania State College. Cloth, 6 x 9 in.; 378 pages; 174 illustrations. New York, McGraw-Hill Book Company. $3 net.

The fact that this work has now gone into a second edition indicates that it has found favor with works managers and college professors. The first edition, published in 1910, was one of the earliest works, after the efficiency movement sprang into popularity, to bring together a great variety of data of value to the industrial manager and the student of the subject. It was quite natural that the book, coming at that time, should attract much attention, and that this has been sustained is indicated by the total issue to date of 6000 copies. While the work has been enlarged to include the most recent data on various phases of the industrial-management problem the general plan of the book has been unchanged. It keeps the excellences of the first edition in its variety and scope, and in the wealth of experience it brings between two covers. It retains, too, the defects of its predecessor, in that it gives on interminable number of forms and describes minutely their use instead of driving home the general principles of the functions which the methods and forms are aimed to fulfill. There is altogether too much of the detail and too little of philosophy and principle. Consequently, while the book is of value as a text to the manager of a plant only now awakening to modern methods, those who are familiar with even fairly good industrial plant management will want something of a more analytical and advanced character.

The first part takes up in detail the various departments of an industry, explains their functions, methods of operation and relation to other departments. Then follow chapters on finance, accounting, factory location and layout and the methods by which the efficiency of plants are studied and betterments introduced. The closing chapter gives a valuable bibliography of works management in two parts. The first contains such works as are necessary for the man who aspires to success in business administration and industrial management; the second is a comprehensive list of supplementary reading for the library of the school of engineering, of business administration or a public library.

A MODEL HOUSING LAW. By Lawrence Veiller. Cloth, 6¼ x 9 in.; 343 pages; 80 illustrations. New York, Survey Associates, Inc. $2 net.

City planning is receiving deserved attention from engineers, for while originally a movement on the part of the social reformers, its logical development cannot be carried on independently of municipal and transportation engineering. Opportunities for influencing the development of new communities are constantly coming to the engineer, and it would be well, therefore, if he were familiar with some book such as the one now in hand. "Its purpose," as stated in the early part of the work, "is to save persons interested in housing reforms many years of effort, and if rightly used should accomplish this purpose. It is intended to make unnecessary the painful operation of collecting the housing laws of all the different cities and States throughout the country, preparing a comparative digest of them, and slowly and painfully setting to work to construct a new law from these elements, cutting a piece here and adding a patch there, the result being a crazy-quilt legislation which does not accomplish what is desired." The author emphasizes, too, that the model housing law presented is only a working model upon which others may build. It is in no sense meant to be an ideal or perfect statute.

The work discusses the necessity for legislation in order to secure housing reform; the differences between building codes, tenement-house laws and housing laws; use of the model law, and then, in about two hundred pages, gives the model law proposed. This is followed by a chapter which shows the kind of houses that can be built under the law, and another proposing a model tenement-house law, where such is desired rather than a housing law. The final chapter presents the provisions which would make the model law ideal. An elaborate index, which greatly increases its value, closes the book.

Letters to the Editor

The Follow-Up Letter

SIR: In the Engineering Record of Feb. 21, on the Publisher's Page, there was a paragraph that particularly appealed to me. In this paragraph you say: "The man who reads advertisements regularly and with a mind on the alert for suggestions, absorbs a very considerable fund of otherwise almost unobtainable information." The writer heartily agrees with this, and has followed the practice for many years. There is one objection to the habit, and that is the desire to know more about some particular device he sees advertised. If one gives way to this desire and writes for a catalog, even if it is particularly stated it is for his file and for future reference, he is almost certain to be bombarded with that most annoying of all advertising devices, the follow-up letter.

If a census of buyers were taken, it is a safe bet that 90 per cent of them would condemn the system, especially in its most violent form of dribbling out in homeopathic doses by means of half a dozen letters or circulars the information sought. If advertisers could be brought to see that buyers, as a rule, at least engineering buyers, have sufficient intelligence to take their information at one dose and know for themselves what they want without being "ding-donged" at, like schoolboys late in May, they would save postage and have their literature more carefully read and preserved.

W. R. SMYTHE,
Consulting Engineer.

San Marcial, N. Mex.

State Building Codes

SIR: In view of your recent editorial on State and city building codes, the statement may be of interest that a Wisconsin State building code has been formulated and will soon be issued by the Industrial Commission of Wisconsin. After public hearings, this code will be adopted by the Industrial Commission under authority of the State law which empowers the commission to fix reasonable standards necessary to the safety and welfare of the occupants of public buildings and places of employment. The latter terms are so defined as to include practically all buildings except private residences.

The new Wisconsin code aims to fix broad standards of fire protection and sanitation—not details of design or arrangement. Thus the code is less than one-half as long as the New York City code. On the engineering or structural side little more is given than tables of floor loads, bearing value of soils, and allowable unit stresses, all of which are made substantially uniform with the new Milwaukee ordinances. A rather unusual provision is one permitting the specified floor loads to be reduced by 20 lb. in fireproof buildings. The reasons for this discrimination are: (1) A fireproof floor suffers little or no deterioration; (2) a fireproof floor is not weakened by a fire below; (3) the greater dead load of a fireproof floor means that any accidental overload is a smaller proportion of the total dead and live load.

The most detailed provisions are those relating to stairways and fire escapes. These are based on the obvious principle that in most cases the open fire escape is at best only a makeshift, and that every effort should be made to secure buildings of such construction, and having such stairways, as to provide reasonably safe escape for the occupants by the usual means of ingress and egress. Fire-resisting construction and inclosed stairways are required wherever this can reasonably be done, and in all cases such construction receives a proper preference in many ways. The value of fireproof dividing walls and "horizontal exits" is recognized, though to a less extent than is done in the New York factory laws. In apartment houses a covered outside rear stairway is recommended, which acts as a service stairway and fire escape combined; and where this is provided, no fire escape is required.

Comment on the proposed code is cordially invited. Copies may be obtained from the Industrial Commission, Madison, Wis. **SIDNEY J. WILLIAMS,**
Building Inspector, Industrial Commission of Wisconsin.
Madison, Wis.

Trenching in Quicksand

SIR: The conclusions drawn by W. W. Brigden in his article on quicksand excavation published in the Engineering Record of Feb. 7 are likely to be misleading, as his method of handling water in wet trenches could have been improved upon. The writer has constructed about 5 miles of sewers in water-bearing sand and under the most unfavorable conditions in crowded alleys and trenches up to 16 ft. deep with 14 ft. of water. The total cost for hand excavation, pumping, sheeting and repairs was less than $2 per foot.

For pipe sewers up to 20 in. the trenches should be 5 ft. outside of sheeting, the sheeting being driven in stages to within 3 ft. of the bottom of excavation. For handling the water well-points connected to 11-ft. pieces of pipe are driven 3 ft. apart on each side of the trench. These are jetted down 12 to 18 in. from the top of the screen to the flow line of the sewer and connected to the suction line through 3-ft. sections of 1¼-in. hard rubber hose. The well-points are 1¼ x 36 in. and either 60 or 80 gage are found to give equally good service. A 3-in. suction line is large enough to handle the water in nearly all cases with from 30 to 40 well-points in operation at one time. The sections are 21 ft. long, double strength pipe, and tapped every 3 ft. for 1¼-in. cross valves. To facilitate moving ahead, flanged gate valves are connected between each section.

The writer has experimented with a number of different pumps and for the conditions cited above has found a power-driven triplex pump with a capacity of 400 gal. per minute the most satisfactory. This type will also serve for jetting. Although the discharge is not more than 250 to 300 gal. per minute, a pump of larger capacity is necessary on account of small air leaks in the suction line.

Specifications for mortar in wet trenches usually call for a 1:1 mixture of natural cement and sand, but it has been found advisable to use pure cement. The greatest care is necessary in mixing, making a stiff mixture so that samples of fresh cement submerged in water will not crumble. This will avoid many leaks and more than pay for the extra amount of cement, besides allowing the water to be turned on the sewer much sooner than if a sand and cement mixture were used.

M. W. HOLBEN,
Gary, Ind. Constructing Engineer.

[Copy of Mr. Holben's letter was submitted to Mr. Brigden, whose reply follows. —EDITOR.]

SIR: I have read Mr. Holben's criticism of my article on trenching in quicksand. I do not object to the statement of Mr. Holben that my system of handling the trenching could be improved upon. I distinctly stated in my paper that I thought it could be. It was our first attempt in such very bad material, and we greatly improved our outfit during the time we were working.

As to Mr. Holben's statement that he has put in 5 miles of sewers in water-bearing sand in Gary, I have had an experience of more than twenty-five years in sewer construction, both by contract and day work. During that time I have had charge of the construction of more than 30 miles of sewers. I see no use in any ordinary case of driving sheeting in stages unless the depth exceeds 12 ft. and this will at least hold good if ordinary 2-in. plank is used. We usually drive 14-ft. lengths in the first stage.

Probably Mr. Holben's idea of jetting the well points is a good one, although of course it would not do in the case of many of the wells we put down because they went several feet into sandstone rock. We used some larger pipe than was necessary for suction lines, but we had some of the pipe on hand. It was better to use a size or two larger than to buy new pipe, and our flow of water evidently greatly exceeded the flow found in Gary.

Our wells were not placed so close together as the ones Mr. Holben mentions and quite probably we would have fared better had we placed some of ours closer, but it must be remembered that this was not a very long trench and the conditions were more difficult than anything heretofore found in our city. We used gate valves, although not flanged ones; ours had screwed ends, which I think in some cases preferable.

We used all kinds of cement mixes and yet that did not prevent the ground-water from breaking through in a few places. I do not think any ordinary slow-setting Portland cement would have prevented this leakage without some kind of gasket, and much prefer the cloth roll of cement driven into the joints to any form of mortar applied without protection. We used considerable neat dry cement to stop the inflow of water where it seemed advisable.

I am quite satisfied that the cost of some of our work was excessive, but such work as we did could not be done for $2 per foot. I judge Mr. Holben's work at Gary did not cover the removal of innumerable boulders, nor the handling of sandstone rock. It is generally conceded that rock excavation is worth from $1 to $2 per cubic yard, even if the rock is only moderately hard, and we removed a great many yards of this rock in the presence of much water. My estimate included pipe, engineering, superintendence and everything connected with the work, as well as those mentioned by Mr. Holben.

If we have any more excavation of the same kind I shall try some of the suggestions of Mr. Holben, but would not expect to come anywhere near his cost figures and must conclude his conditions at Gary are not to be compared with ours. A 6-in. well in lake sand, as at Gary, would yield from 10,000 to 20,000 gal. per day under 20 ft. static head. Our wells in sandstone rock yielded over 1,500,000 gal. per day by carefully conducted weir tests, and some of them 2,000,000 gal., so there could be no comparison as to the amount of water it was necessary to handle.

We paid our well contractor 50 cents per linear foot for driving 2-in. wells. These wells average 16 ft. deep and if we placed ours as close as those put in at Gary, 3 ft., the cost of wells, without material for them or piping to the pumps, would be $2.70 per foot. We have put down many 2-in. wells and this is about the regular price, and a reasonable one as to profit. It costs from $1.50 to $2 per linear foot to build a 12-in. sewer 10 to 12 ft. deep in ordinary earth excavation without ground water, if the work is first class and all expenses, including engineering and assessing, are taken into account. How then can the most difficult parts of such work as ours, in material containing far more water than at Gary, be done for any such price as $2 per foot? I think those who have handled such work as ours will say it cannot be done.

W. W. BRIGDEN,
Superintendent and Engineer, Department of Public Works.
Battle Creek, Mich.

Status of Hydroelectric Design

SIR: After my return from the Big Creek plants in California I read your issue of Jan. 3, 1914. There is an evident error in the article on page 9, "Status of Hydroelectric Design," by Clemens Herschel, inasmuch as it reads: "The manufacturer sees no reason why an efficiency (of impulse wheels) as high as 80 per cent. could not be obtained under favorable conditions."

The figure should be 90 per cent. instead, the writer having made tests some three years ago with impulse buckets designed and built by the Allis-Chalmers Manufacturing Company of Milwaukee, Wis., which showed efficiencies as high as 88.75 per cent.

Fresno, Cal. **ARNOLD PFAU.**

[The typographical error referred to is apparent to anybody who reads the whole paragraph and not only the last sentence. —EDITOR.]

Pavement Design to Suit the Traffic Requirements

SIR: The recent special message of the Governor to the New York State Legislature, in which the exclusive construction of brick highways is recommended, calls fresh attention to what the writer believes are extremist ideas regarding the abandonment of certain types of pavement of long-proved value. Though the automobile and automobile truck have undoubtedly increased the proportion of highways requiring the hardest type of pavement, it is nevertheless true that the construction of such pavements, of block or concrete, is always a sacrifice of the qualities most desirable for horse-drawn traffic in order to secure the endurance requisite for the motor-driven vehicles.

On the direct interurban highways constituting parts of through automobile routes there can be no question that only hard pavements should be built, but for the majority of country roads, designed properly for the equal service of both types of traffic, the writer believes that the bituminous-macadam pavement, combining as it does the hardness and toughness of the stone with the elasticity of the binder, is nearly ideal for the purpose, and that to discard it would be to abandon an exceptionally successful design which has taken years of experimenting to obtain and is only now reaching its perfection.

It is doubtless true that the construction and failure of imperfect bituminous roads, mainly through ignorance of principles now becoming fully understood, have led to unjust criticism of this type of construction. Thanks to the scientific study of binders, notably by the U. S. Office of Public Roads, the selection of these materials may now be made with full assurance of success; and though engineers differ in their ideas as to some details of construction, the methods followed are becoming similar in their essential features, and an increasing number of extremely good roads are being built.

The construction now probably most often specified, namely, a foundation of stone of commercial 2½-in. size, filled with screenings or clean sand, a 4-in. top course of 1½ or 1¼-in. stone with voids completely filled with proper native or residual asphalt or tar binder, and a final carpet of screenings applied and rolled over the hot binder and again over a second "seal" coat of the same binder, is probably capable of little improvement. The writer believes, however, that the final "carpet" is a matter of the utmost importance, and that it should be laid so as to cover from sight the stone of the top course, and that just as soon as the top-course stone begins to appear to any considerable extent it is time to renew the carpet, always using for the purpose a binder hardening mainly by volatilization and containing sufficient binding base to bond to the surface of the road and become an integral part thereof. In fact, if the binder used for the top course is low enough in its melting point to "bleed" under summer temperature, the road can hardly be regarded as finished until the first maintenance application has been made. A real "carpet" is essentially a bituminous mortar, and to produce it the screenings must vary in size from about 1/16 to about ⅜ in., these sizes being respectively the smallest that the top-course binder is fluid enough to surround and the largest that the maintenance binder will hold. Such screenings can be obtained on the market, and the writer believes that neither the "½-in. clean" "screenings" (bearing dust) nor the "¾-in." sometimes specified is a satisfactory material for sealing the top course, or will produce either as smooth or as durable a road as the graded material.

There seems to be a considerable trend of engineering opinion in favor of abandoning all but the most indestructible pavements, while the better policy would be the standardizing of design in each of the types which experience has shown to possess the greatest merit for given conditions and the careful selection for every pavement of the type best suited for its particular purpose. Nothing in highway design is to-day more important than the insistence that every type of pavement should be built only in the greatest perfection for that type. For private estates and drives the writer believes that the ideal road to-day is a water-bound macadam, built of proper thickness, with the top course thoroughly filled with stone dust and puddled till set. A water-bound road, half filled with unsuitable material, might formerly have survived, under light traffic, but a single accidental trip over it to-day by an automobile truck is enough to leave portions of its surface badly damaged, and too often the fault is laid to the type of road instead of to the fact that the particular road examined was never built according to the proper standards of any type.

The penetration method of construction is occasionally condemned as obsolete or obsolescent. The writer can point to one penetration road which has carried heavy automobile traffic on a steep grade for four years without any maintenance whatever and in which it is difficult to find that a single stone has been displaced (though the carpet is entirely gone). He could point to others which were badly raveled at the end of their first season; but investigation in such instances shows violation of fundamental principles of design, to which the failure should be attributed.

New York City. WALTER S. ST. JOHN.

World's Concrete Placing Record

SIR: Referring to the article in the Engineering Record of Feb. 21, 1914, page 216, entitled "World's Concrete Placing Record," I would say that the record shown in this article is not a world's record by any means, as this record was broken month after month on the lock construction in the Canal Zone. The following figures show the quantity of concrete placed per month for the year beginning June 1, 1910, and ending May 31, 1911:

Month	Cu. yd.	Month	Cu. yd.
June, 1910	89,401	December	80,212
July	84,001	January, 1911	72,919
August	85,686	February	72,103
September	76,720	March	86,884
October	86,949	April	67,361
November	75,152	May	67,844

The total concrete placed during the twelve months detailed above aggregated 945,232 cu. yd.

The following data compiled from work performed during the month of March, 1911, show a record far in excess of the record for the Kensico dam of the Catskill Aqueduct, and this record was not only equaled on other occasions, but was exceeded in June, 1910:

Total masonry placed in Gatun Locks during month of March, 1911	86,884
Number of working days during month	27
Number of hours in working day, average	10
Average number of 2-yard "mixer hours" per day	50.17
Average quantity of masonry placed per day, cu. yd.	3,217.9
Average quantity of masonry placed per hour, cu. yd.	321.8
Average quantity placed in form of blocks per day, cu. yd.	211.03
Average quantity run through mixers per day, cu. yd.	3,006.9
Average output per mixer hour per month, cu. yd.	59.93
Best day's run, cu. yd.	3,241
Average output per mixer hour for best day, cu. yd.	66.3

In addition to the record made on the Gatun Lock work in the Canal Zone, would say that the Kensico Dam record for masonry work was excelled at different times on the Pedro Miguel and Miraflores Locks. In October, 1910, in twenty-six working days (8-hour) 68,368 cu. yd. of concrete were placed, and in November, 1910, in twenty-five 8-hour working days 68,725 cu. yd. of concrete were placed in the Pedro Miguel Lock. The quantities, etc., from which the data presented herewith have been compiled are a matter of official record.

J. EDWARD CASSIDY.

Huntington, W. Va.

Electrically Operated Underground Mail Tubes

SIR: I noticed in your issue of about Dec. 1 descriptions of electrically operated systems of underground tubes, for the transportation of mail and express matter. In one of these articles, mention was made of an 18-in. pneumatic tube, in operation between the Capitol and the House Office Building, in Washington, such being described as "crude and noisy."

I have served a long experience in engineering and contracting works, among them the construction of the Pennsylvania Railroad station and two miles of the old subway in New York City, as well as considerable operating experience on railroads, and in such experience have had much to do with various machinery for accomplishing transportation of one kind and another.

For the past 18 months I have devoted my time exclusively to the study of the problem of transporting mail and express in the large cities, as I believe that this is one of the most important transportation problems of the day. In my opinion, a system of a type similar to this one mentioned offers the best solution of the problem, for the following reasons:

It is most dependable, because there are no electrical complications, nor dangers of derailment or collision possible; it is cheapest to construct and operate; has the greatest car capacity per inch of tube or conduit bore; has the greatest capacity for number of car movements per hour; is most automatic in its operation, and is most readily adaptable to the requirements of such a service.

R. G. COLLINS, JR.,

Washington, D. C. M. Am. Soc. C. E.

Gas Analysis at Atlanta Sewage-Disposal Plant

SIR: I am inclosing copy of an analysis of the gases from the vents of the Imhoff tanks at the Peachtree Creek sewage-disposal plant. This plant has been in operation since last October and therefore the gases may reasonably be supposed to be such as we will get during the normal operation of the plant.

PERCENTAGES OF GAS COLLECTED FROM CENTRAL GAS VENT OF TANK 1A

	Carbon dioxide	Oxygen	Hydrogen sulphide	Methane	Hydrogen	Nitrogen
Sample 1	4.7	0.3	0.0	85.3	9.7	0.0
Sample 2	5.2	0.5	0.0	82.8	8.2	3.3
Sample 3	4.4	0.6	0.0	84.2	7.9	2.9
Sample 4	4.2	0.4	0.0	....	...	...
Average	4.6	0.4	0.0	84.1	8.6	2.1

C. C. Hommon, bacteriologist and chemist, made the analysis.

W. A. HANSELL, JR.,
Assistant Chief of Construction.
Atlanta, Ga.

RAISING THE "MAINE" from Havana Harbor by the use of an elliptical cofferdam of interlocking steel-sheet pile cylinders, as described in several articles in the Engineering Record, cost $785,774.83, according to the recently published final report of the board of engineer officers, consisting of Col. William M. Black, Lieut.-Col. Mason M. Patrick and Maj. H. B. Ferguson. The total appropriations for this work amounted to $900,000. The first pile of the cofferdam was driven Dec. 6, 1910, and the last March 31, 1911. The wreck was floated, towed out to sea and sunk on March 16, 1912.